Republic of Serbia

First National Report

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

March 2018

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Section A. Introduction

A.1 Overview

SFR Yugoslavia was member state of the International Atomic Energy Agency[1] since September 1967. After the desintegration of SFR Yugoslavia at the beginning of 1990's, and her suspension from the UN, memebership to the IAEA was also suspended. Steate Union of Serbia and Montenegro (former FR Yugoslavia established in 1992) become the memeber state of the IAEA in 2001. Republic of Serbia is a legal successor of State Union of Serbia and Montenegro after its desintegration in 2006.

Generation of radioactive waste in Republic of Serbia started in late 1940's shortly after the Vinča Institute near Belgrade was established. Vinča Institute was established as Institute for Physics on January 10th 1948, with direct governmental management of the Government of Federal People's Republic of Yugoslavia. During the first several years the basic infrastructure for research in physics, chemistry and biology has been built. Multidisciplinary research field of the Institute for Nuclear Sciences was shaped by construction and the beginning of operation of research reactors RA and RB in the end of 1950's, establishment of laboratories for high activity chemistry, reactor materials, radiological and medical protection and nuclear reactor technology.

The beginning of research work in physics was based on development of methods and instruments for the detection and measurements of radiation. In the field of chemistry basic research of national reserves of nuclear mineral raw materials and their mining and milling methods were performed up to the level of a "yellow cake" production. Until 1955, Laboratory for technologies of Vinča Institute had the task to develop method for uranium production from ores with low uranium content.

Since 1947, activities on uranium and thorium prospection have been organized in the Institute for geological and mining research. Uranium mine near Kalna (Eastern Serbia, Stara Planina Mountain), was considered as the most promising one. The first analyses of those ores have been performed in Chemical laboratory of Vinča Institute. After the reorganization of the Vinča Institute in 1955, uranium mining and milling activities were transferred completely into newly established Institute for Nuclear and Other Mineral Raw Materials.

During its history, Vinča Institute was reorganized significantly several times: from one, completely state controlled and financed Institute, exclusively in nuclear research, through several almost independent organizations with the broad scope of research oriented to industrial applications in mid-70-ies to one strong multidisciplinary market-oriented research institution in 90-ies. Finally, establishment of Public Company Nuclear Facilities of Serbia[2], was the last organizational change, putting nuclear operations again under direct state control. Uranium mine and hydrometallurgical plant in Gabrovnica near Kalna were also included in PC NFS. Vinca Institute is now multidisciplinary research institute with focus on the research in the field other than nuclear technologies.

Desintegration of former Yugoslavia in early 1990's followed with economical crisis lead to the significant decrease of all research activities in the nuclear field. Lack of human resources due to the ageing and brain-drain also have the great impact to the lost of knowledge and experience which is necessary for the current radioactive waste management activities.

[1] In the text below: IAEA

[2] In the text below: PC NFS

A.2 Legal framework

Parliament of the Republic of Serbia adopted, in May 2009, Law on Radiation Protection and Nuclear Safety[3] (Official Gazette RS 36/09 and 93/12). This Law stipulates measures for protection of human life, health and environment from harmful effects of ionising radiation and nuclear safety measures regarding nuclear activities. It also regulates the conditions for practices with sources of ionising radiation and nuclear materials, as well as radioactive waste management.

In the Republic of Serbia is in force the Law on banning the construction of nuclear power plants (Official Gazette FRY 12/95 and Official Gazette RS 85/05). Under that Law, it is forbidden to build nuclear power plants, nuclear fuel production plants and plants for reprocessing spent nuclear fuel for nuclear power plants. It is also forbiden to making investment decisions, investment programs and technical documentation for the construction of nuclear power plants, production plants for nuclear fuel and plants for reprocessing spent nuclear fuel for nuclear power plants.

Regulations and rulebooks in the field of spent fuel and radioactive waste management safety are:

- Regulation on determining the programme of nuclear safety and security (Official Gazette RS 39/14)
- Regulation on the security measures of nuclear facilities and nuclear materials (Official Gazette RS 39/14)
- Rulebook on performance of nuclear activities[4] (Official Gazette RS 37/11)
- Rulebook on conditions for obtaining licence to perform nuclear activity[5] (Official Gazette RS 37/11)
- Rulebook on radioactive waste management[6] (Official Gazette RS 60/11)
- Rulebook on limits of exposure to ionizing radiation and measurements for assessment of the exposure levels[7] (Official Gazette RS 86/11)
- Rulebook on radioactivity monitoring[8] (Official Gazette RS 97/11)
- Rulebook on limits of radioactive contamination of people, working and living environment and ways of performing decontamination (Official Gazette RS No. 38/11)

In order to provide the conditions for implementing the policy in the area of nuclear safety and security, the Government adopted the Nuclear Safety and Security Programme. This Programme serves to determine long-term plans and objectives regarding nuclear activities in accordance with the standards and principles of the international organizations in these areas, as well as international commitments.

Security of nuclear facilities is regulated by Regulation on the security measures of nuclear facilities and nuclear materials. This Regulation prescribes the security measures applied by licensee for performing nuclear activities in order to secure nuclear facilities and nuclear materials.

Rulebook PNA regulates and governs reporting about the operation of nuclear facilities; conditions for staff and the integral quality management system for the performance of nuclear activities.

Rulebook COLPNA prescribes the documentation submitted with the licence application for performing nuclear activities.

[3] In the text below: Law 2009

[4] In the text below: Rulebook PNA

[5] In the text below: Rulebook COLPNA

[6] In the text below: Rulebook RWM

[7] In the text below: Rulebook LEIR

[8] In the text below: Rulebook RM

Rulebook RWM prescribes the method of storage of radioactive waste generated in operation; the manner and conditions under which the radioactive waste is kept, collected, recorded, stored, processed and disposed and the manner of keeping records about radioactive waste and timelines for delivering the records to the regulatory body.

Rulebook LEIR prescribes types, manner and time interval of measurements for assessment of levels of exposure to ionizing radiation of professionally exposed persons, patients and population; content of the report of measurements for assessment of levels of exposure to ionizing radiation of professionally exposed persons, patients and population; manner of keeping records, records retention period, the procedure to inform the competent authorities as well as exposure limits for professionally exposed persons, persons on trainning and population.

Rulebook RM stipulates the methods and requirements for the systematic environmental radioactivity monitoring and systematic environmental radioactivity monitoring in surroundings of the nuclear facility.

Compete list of all relevant legal acts is given in Annex L.2.

A.3 Institutional framework

Serbian Radiation Protection and Nuclear Safety Agency[9] was established by the Decision on establishment of the Serbian Radiation Protection and Nuclear Safety Agency (Official Gazette RS 76/09 and 113/13), adopted by the Serbian Government, according to Law 2009 and Law on public agencies, with the purpose of ensuring the conditions for quality and efficient radiation protection and nuclear safety measures while performing radiation practices and nuclear activities. According to Article 5 of the Law 2009, SRPNA was established as a regulatory organization performing public authorizations in accordance with the Law 2009. Ministry of Environmental Protection as ministry responsible for radiation protection provides financial resources for the SRPNA from the state budget. The state budget is the only source for financing of the SRPNA's activities. SRPNA has the Management Board which consists of 5 members, appointed by the Government.

Under Article 77 of the Law 2009 the control over the SRPNAs work in performing the entrusted tasks shall be performed, within its scope, by the Ministry responsible for radiation protection and the Ministry responsible for nuclear safety and radioactive waste management, in accordance with the regulations governing the government administration.

Under Article 76 of the Law 2009 inspection control over implementing radiation protection measures shall be performed by the Ministry responsible for radiation protection through the inspector for radiation protection. The same article prescribes that inspection control over implementing nuclear safety measures shall be performed by the Ministry responsible for nuclear safety and radioactive waste management through the inspector for nuclear safety and radioactive waste management.

At the time of writing this report Ministry responsible for radiation protection is Ministry of Environmental Protection while the Ministry responsible for nuclear safety and radioactive waste management is the Ministry of Education, Science and Technological Development.

Article 48a of Law 2009 foresees that nuclear facility management in the Republic of Serbia is an activity of public interest. To perform these activities a public company shall be established. PC NFS was established in 2009 to manage nuclear facilities listed in Governmental Decision on Establishment of public company for nuclear facility management (Official Gazette RS 50/09). These facilities are two research reactors RA and RB, radioactive waste storage facilities H0, H1, H2, H3 and Secure Storage, liquid radioactive waste storage tanks VR1-VR4, Waste Processing Facility and so-called Radium Bunker, all previously managed by Vinča Institute, and hydrometallurgical plant in Gabrovnica near

[9] In the text below: SRPNA

Kalna (Eastern Serbia, Stara Planina Mountain), previously managed by Institute for Technology of Nuclear and Other Mineral Raw Materials.

A.4 Present and past practices and activities

Use of radioactive sources in medical practices in Republic of Serbia dates back to period before Second World War. Extensive use of radioactive sources and materials started after the establishment of Vinča Institute near Belgrade in late 1940's. Radioactive sources and materials are used since then all around country in medical, industrial and research purposes.

The only nuclear fuel cycle facilities in Republic of Serbia are research reactors RA and RB and former uranium mine and associated hydrometallurgical plant in Gabrovnica near Kalna. Construction of nuclear power plants, nuclear fuel production plants and plants for processing spent nuclear fuel for nuclear power plants is forbidden.

Radioactive waste management facilities in the Republic of Serbia are storage hangars H0, H1, H2, H3 and Secure Storage, liquid radioactive waste storage tanks VR1-VR4, Waste Processing Facility and so-called Radium Bunker. Until early 1990's all radioactive waste generated in former Yugoslavia was stored in these facilities. Radioactive waste generated in Republic of Montenegro was also stored in these facilities until desintegration of State Union of Serbia and Montenegro. All radioactive waste generated in Republic of Serbia nowdays is stored in these facilities.

A.4.1 Vinča site

Micro location for Vinča Institute has been chosen in 1947. The site is 15 km east from the city center of Belgrade, and 2 km south of river Danube. At those times, it was unpopulated small village near Neolithic archeological location. Nowadays, demographic picture has changed, and the nearest houses are almost next to the fence of the site.

The small creek named Mlaka passes through the site, collecting atmospheric waters arround the facilities and eventual leeks to underground waters. From 1959 until 1984, the heavy water research reactor RA (6.5MW) has been in operation [1]. Meteorological and radiological measurements at the site and in its surroundings have been conducted since the start of operation of the research reactor RA and are continued until today. Safety relevant characterizations of the location are given in several different safety analysis reports.

In the Figure 1, layout of Vinča site is given. Positions of the facilities operated by PC NFS are given in red shade.

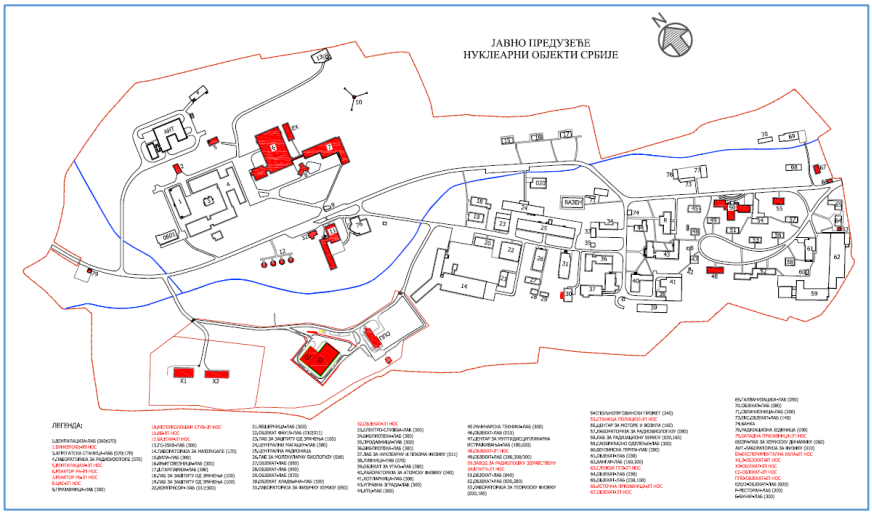

Figure 1. Vinča site

A.4.1.1 Research reactors

Research reactor RA

Nuclear research reactor RA was constructed in the second half of the 1950's, based on the Soviet design [1]. Main components of the reactor were manufactured in the former Soviet Union. The reactor was designed as a multi-purpose research reactor providing a relatively high neutron flux in the core. The research reactor RA is a tank type reactor using heavy water as a primary coolant and as a moderator. Heavy water circulated through the primary cooling system by upward forced circulation in order to remove the heat from the fuel elements in the core. Its full power was 10 MW, and a nominal one 6.5 MW. Picture of the research reactor RA is given in Figure 2.

Figure 2. Research reactor RA

The facility went critical in December 1959 and was temporarily shut down in August 1984. During period of operation, reactor has been successfully used for scientific research and for commercial purposes. During operation of the research reactor RA, only TVR-S type of fuel elements manufactured in the former Soviet Union were used. From its first criticality in 1959, until 1975, the reactor used low enriched uranium fuel[10] (2% of ^{235}U). In 1976, the original fuel was gradually replaced by a highly enriched fuel[11] (80% of ^{235}U). From September 1981, only HEU elements were used in reactor core.

Figure 3. Fuel element TVR-S type

Both types of fuel elements (LEU and HEU) have the same geometry, but the mass of ^{235}U is slightly different (7.25 g in LEU and 7.7 g in HEU fuel element). TVR-S fuel element is an empty cylinder with

[10] In the text below: LEU

[11] In the text below: HEU

the outer diameter of 37.2 mm having tubular fuel section 2 mm thick and 100 mm long. This section, coated with 1 mm aluminum cladding, is made of metal uranium in LEU and uranium dioxide mixed in aluminum matrix in HEU fuel element. Total length of the fuel element is 113 mm. Picture of TVR-S type fuel element is given on Figure 3.

The fuel elements were placed in an aluminum tube (11 elements per tube), forming thus a fuel channel in reactor core. The full core consisted of 82 such channels forming the square reactor lattice with 130 mm pitch. The fuel channels are aluminum tubes ϕ 43/41 mm and 5.45 m long, with an extension of 113 cm at the bottom, entering the hole at the upper bottom plate of the inner reactor vessel.

The active zone of the reactor is situated inside the inner aluminum reactor vessel, surrounded by the graphite reflector, by the outer stainless steel reactor vessel and by the biological shield of water and heavy concrete. The active zone is cylindrical with 1.40 m in diameter and 1.23 m high. The inner diameter of the reactor vessel is 1.405 m up to the height of 3.6 m, and 1.62 m above it. Wall thickness of the vessel is 8 mm, with a double bottom of 20 mm thickness (upper plate) and 30 mm thickness (lower plate). Total height of the outer reactor vessel is 6.06 m. Wall thickness is 15 mm, while diameter is 2.66 m in the lower part (around the graphite reflector) and 1.645 m in the upper part. Graphite layer between the inner and the outer reactor vessel is 0.60 m thick and 3.0 high. Ordinary water shield comprises of three separate regions: water ring 0.70 m thick around the graphite reflector, bottom water layer 0.40 high and upper water shield with two lateral ring sections 2.0 m wide and 2.2 m high and a cover of 1.8 m thickness. Outer heavy concrete shield is 10.55 m high and 2.0 m thick. Cross section of the research reactor RA is given on Figure 4.

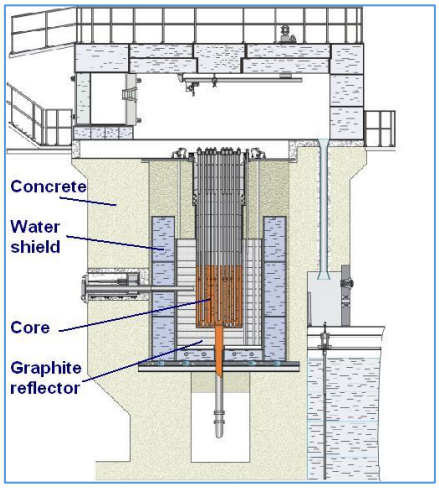

Figure 4. Cross section of research reactor RA

There were 8030 TVR-S fuel elements of both types being irradiated until August 1984. All of them were stored in reactor building in four spent fuel storage pools filled with tap water adjascent to the reactor hall. Pools are interconnected by the channel, which ends inside reactor block. Fuel elements were positioned in aluminium tubes inserted either in stainless steel containers, or in aluminium barrels. Majority consisted of LEU fuel elements (6656) placed in aluminium barrels or in stainless steel channel holders, while HEU fuel elements (1374) have been put into stainless steel channel holders.

Although temporarily shut down in the August 1984 for modernization and preparation for further operation, research reactor RA was never re-started. Government of Republic of Serbia adopted Decision in 2002 on its final shutdown. Fresh HEU fuel elements were transferred to Russian Federation as country of origin in 2002. Spent nuclear fuel from the research reactor RA was repatriated to the Russian Federation in 2010.

Abnormal events during operation

Good quality of the equipment and well qualified persounel have contributed to the fact that no accidents have ever occurred during 25 years of reactor operation. A lot of incidents leading to unplanned shutdowns of the reactor have happened, what is to be expected for such a facility.

Three major incidents leaded to temporary shutdowns of the reactor for a longer period of time and generation of some specific radioactive waste.

Cobalt contamination

During the testing period of the reactor primary cooling circuit was contaminated with cobalt. As a result of this contamination high radiation levels of primary circuit components and presence of cobalt contamination in heavy water have been discovered in 1963. This lead to temporary shut down of the reactor.

For a relatively long time there was no explanation of the presence of cobalt in heavy water. After major maintenance of primary cooling circuit pumps, it was found out that shafts' bearings of these pumps were coated with a steel alloy containing high content of cobalt. The pumps were designed for use in chemical industry where cobalt content was of no significance. These bearings were replaced.

Although, the inner reactor vessel, the pipe-lines and other components of the primary cooling circuit have been thoroughly decontaminated afterwards, relatively high activities of these components were only slightly reduced.

Fuel failure

More than 8000 fuel elements have been irradiated in the research reactor RA core, and there was only one fuel failure that happened during operation in 1970.

Immediately after regular start-up of the reactor in September 1970, significant increase of radioactivity of gas mixture in helium circuit has been detected. After shutdown, the measurements have shown the presence of isotope ^{137}Cs leading to a conclusion that a fuel failure occurred. Fuel channel with failed fuel element has been discovered using gas samples from each channel in reactor core. This channel was immediately transferred to the spent fuel storage pool and hermetically closed.

The primary coolant circuit of the reactor was also contaminated with fission fragments during that incident. Small contamination of water in the storage pool has occurred due to repackaging procedures during transfer of irradiated fuel from reactor to the spent fuel storage.

Corrosion of fuel elements cladding

A severe occurrence of the problems with corrosion products creation and their deposition on the primary cooling circuit components has been discovered in the research reactor RA core in March 1979. This incident led to almost 2.5 years of reactor shutdown.

The main characteristics of the phenomenon has shown up to be in huge aluminum oxidation deposits on the outer surface of fuel elements cladding, preventing pulling out of these elements during refuelling procedures.

Thorough investigations and analyses have been made during shutdown period. Certain measures in preventing this phenomenon have been undertaken. Nevertheless after one year of operation the reactor had to be shutdown for another six months due to the same problem.

Analyses and measures that have been planned for further operation of the reactor in order to prevent corrosion products deposition on fuel elements cladding have never been realized due the reactor shutdown in August 1984.

Reactor shutdown

After temporary shutdown in 1984 followed by thorough examinations of its systems and equipment, it was decided to make some reconstructions of the reactor RA in order to enable its safe and continuous operation in the future. The reconstruction, with financial help of the IAEA started in 1986, but due to international sanctions imposed against Yugoslavia in 1992, it has never been finished.

In July 2002, the Government of Republic of Serbia adopted a decision to shut down the reactor RA permanently.

The fresh fuel elements were transported to the Russian Federation in August 2002. Packed in special containers, 5046 HEU fuel elements were transported by truck from the Vinča Institute to the Belgrade Airport and then sent by commercial cargo aircraft to its final destination in the Russian Federation.

In 2004 the Government of Republic of Serbia adopted decision on repatriation of spent nuclear fuel from research reactor RA and its decommissioning. Spent nuclear fuel was repatriated to Russian Federation in December 2010. In accordance with Article 5, para. 3 of the Agreement between the Government of Republic of Serbia and Government of Russian Federation concerning cooperation in the Import of Irradiated Nuclear Fuel from a research Reactor into the Russian Federation from June 10, 2009, no products generated by the reprocessing of the irradiated nuclear fuel including generated uranium and plutonium and radioactive waste, shell be returned to the Republic of Serbia.

With regard to the future research reactor RA decommissioning it has to be mentioned that the water shield between graphite reflector and concrete shield contributed to a small neutron induced activity in concrete shield. On the other hand, the neutron induced activities in the graphite reflector, reactor aluminum and stainless steel vessels, and barite sand are very high. Also, it was found that induced Wigner energy in part of the graphite blocks needs to be removed.

Storage of 8030 spent fuel elements of TVR-S type in the spent fuel pool, resulted in a large leakage of ^{137}Cs. At this moment there is significant contamination with ^{137}Cs and ^{90}Sr in about 200 m^3 of spent nuclear fuel pool water. Significant part of ^{137}Cs was removed from water during the repackaging of the spent fuel. Removal of ^{137}Cs from water was done using water contamination control system with ion exchange resins. These rasins were subsequently stored inside the pool. In addition, there is about 2 m^3 of water in stainless steel containers used for storage of spent fuel elements contaminated with ^{137}Cs. Stainless steel channel holders and supporting structure are also inside storage pool.

There is also significant quantity of radioactive and contaminated materials in dry pool next to the spent fuel pool.

Total volume of 5.5 m^3 of heavy water stored in heavy water tank has significant amount of tritium.

There is certain amount of sealed and unsealed ^{60}Co sources stored in hot cells of reactor RA.

Research reactor RB

At the very beginning the reactor RB was designed and constructed as an unreflected zero power heavy water - natural uranium critical assembly. First criticality was reached in April 1958. Later, the 2% enriched metal uranium fuel and 80% enriched UO_2 fuel were obtained and used in the reactor core [4]. Picture of reactor RB is given in Figure 5.

Initial core in 1958 was loaded with natural metal uranium fuel. Power excursion accident, in which six persons were heavy irradiated, one of them fatally, occurred at the reactor only six months after the first start-up. There were no significant damages of fuel elements or other reactor components or systems.

In 1962, 2% enriched metal uranium fuel TVR-S type became available and the first safety analysis report was written. A study of possibility to use reactor RB as source of fast neutrons began in 1976, when the HEU fuel elements of TVR-S type were bought.

Modifications of the reactor control, safety and dosimetry systems done in 1960, 1976 and 1988 converted the RB critical assembly to a flexible heavy water reflected experimental reactor with 1 W nominal power, operable up to 50 W. Several coupled fast-thermal systems were designed and constructed at RB reactor in the early 1990's, for the research in fast reactors physics.

The only nuclear fuel existing at the time of writing this Report in the Republic of Serbia is natural metal uranium rods placed in dry storage in reactor hall and LEU fuel elements TVR-S type in the reactor core. The burn-up level of fuel is very low due to low power.

Activation of all construction and all other materials in reactor vessel and supporting structires is negligible, and activity concentrations are quite below clearance levels. Activity concentration in graphite of thermal column are also below clearance levels.

Figure 5. Research reactor RB

A.4.1.2 Radioactive waste management facilities

Generation of radioactive waste in Republic of Serbia started in late 1940s shortly after the Institute of Nuclear Sciences in Vinča near Belgrade was established. At the beginning, solid radioactive waste generated in whole Yugoslavia was stored in standardized steel drums and buried in shallow repository in the center of the Vinča site. Later, purpose of this location was changed and drums was transferred to new location near current hangar H2 where it was stored in open space and subsequently moved to storage facility H2 during the 1980's. Radioactive waste generated at that time originated from industrial, medical and research activities. Such radioactive waste demanded measures for safe and secure storage and in 1968 first radioactive waste storage facility Hangar H1 was built. This facility accepted radioactive waste until 1982 when it was closed due to high dose rates in several areas inside. By that time new storage facility Hangar H2 was built. This facility accepted radioactive waste since 1984 until 2012 when it was closed due to lack of storage space.

Liquid radioactive waste produced during period of extensive research was stored in four underground liquid waste tanks made of concrete with stainless steel liner. These tanks contain radioactive waste generated in the research reactor RA and Laboratory of Chemical Dynamics of the Vinča Institute to which they are connected through underground piping.

By the beginning of the 21st century it became clear that existing storage facilities cannot provide enough space for activities planned in the near future. These activities include decommissioning of the research reactor RA, processing of waste stored in existing waste storages, decontamination and potential decommissioning of these facilities and subsequent remediation of their locations. Because of that, new storage facilities Hangar H3 and Secure Storage were constructed in the period from 2007 until 2010. These facilities started to accept waste after receiving license for operation in 2012.

Radioactive waste management facilities in Republic of Serbia are:

- Hangar H0
- Hangar H1
- Hangar H2
- Hangar H3
- Underground liquid radioactive waste tanks VR-1, VR-2, VR-3 and VR-4
- Radium Bunker

Detailed description of all radioactive waste management facilities are given in Section B.

A.4.2 Kalna site

The technology of uranium derivation from ore, carried out at the Institute for Technology of Nuclear and other Raw Materials, represented a solid basis for design and construction of uranium processing hydrometallurgical facility. The facility was constructed in 1963, in the village Gabrovnica, in the vicinity of uranium mine Kalna, and in the same year it was fully operational.

At the time of beginning of operation in 1963, the designed capacity was 200 tons of ore per day, with expected uranium content of ~300 g per tonne of ore. Plant consisted of a mining tunnel, bathrooms, mills, filtration, boiler rooms, warehouses, workshops, pumping stations, transformers, administrative office and tailings. Picture of the facility at the time of operation is given in Figure 6. The plant produced about 900 kg of UO_2 and 400 kg of metal uranium. The ore from the mine was of poor quality with very low uranium content, which required more expensive methods of extraction and processing. Facility operated with a capacity between 23 and 50 tons of ore per day. Shortly after the completion of the research, and due to many circumstances, the facility was shut down in 1965. Main entrance to the mine tunnel was blocked with concrete wall as given in Figure 7.

According to the decision of the Government of Serbia on the establishment of the public company for nuclear facilities management in 2009, responsibility for this site was transferred from the Institute for Technology of Nuclear and Other Mineral Raw Materials to the PC NFS.

The facilities at Gabrovnica site are in very bad condition, most of them are ruined and useless as shown in Figure 8 and Figure 9. There is no any decision regarding future activities at this site. Remediation activities has to be performed in order to improve safety on the locaton.

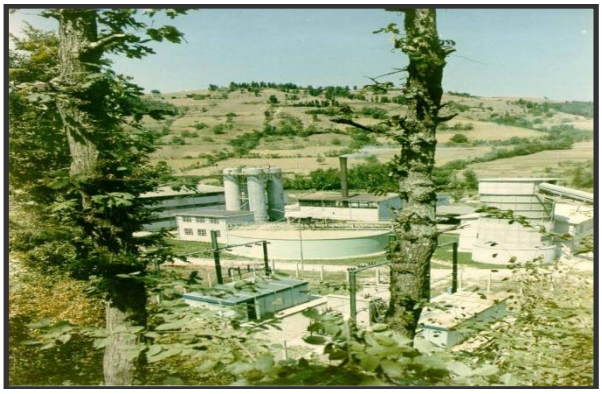

Figure 6. Hydrometallurgical plant for uranium ore treatment in Gabrovnica during operation

Figure 7. Closed mine tunel in Gabrovnica

Figure 8. Equipment of former hydrometallurgical plant

Figure 9. Ruined building in former hydromettalurgical plant

A.5 Spent fuel and radioactive waste management policy and strategy

Law 2009 foresees adoption of the Radioactive Waste Management Programme in line with the regulation on the strategic environmental impact assessment. This Programme shall serve to determine long-term plans and objectives regarding radioactive waste management in accordance with the standards and principles of the international organizations in these areas, as well as international

commitments. This Programme forsees adoption of National Policy and Strategy of spent nuclear fuel and radioactive waste management in line with Council Directive 2011/70/Euratom and the IAEA recommendations. The Programme is still not adopted due to financial reasons.

Law banning construction of Nuclear Power Plants in SFRY was adopted in SFR Yugoslavia in 1989. After desintegration of SFR Yugoslavia the law containing the same provisions was adopted in FR Yugoslavia in 1995. In 2005, Parliament of Republic of Serbia put this Law into force on territory of Republic of Serbia. This Law foresees ban of construction of nuclear power plants, nuclear fuel fabrication plants and nuclear spent fuel reprocessing plants.

Adoption of new Law on radiation and nuclear safety and security is planned for the end of the first quarter of 2019. New Law shall foresee adoption of national policy and strategy which will be in accordance with international standards and relevant EC directive. Basic elements for elaboration of national policy and strategy were prepared and discussed in 2017.

A.6 Current spent fuel and radioactive waste management practice

Solid radioactive waste including spent sealed radioactive sources is stored in four storage facilities namely hangars H0, H1, H2 and H3 and Secure Storage for sealed radioactive sources. Liquid waste is stored in four underground liquid waste tanks namely VR1, VR2, VR3 and VR4.

Hangar H3 intended for storage of solid radioactive waste and Secure Storage intended for storage of spent sealed radioactive sources are operational. Other facilities are closed and do not accept radioactive waste. Radioactive waste that does not fulfil waste acceptance criteria for Hangar H3 can be temporarily kept in separate licensed facility – Hangar H0 until the infrastructure for treatment become available.

In Republic of Serbia radioactive waste is currently generated in medical, industrial and research activities. Besides operating storage facilities, radioactive waste can be kept by legal entity that generated this waste but no longer than one year according to the article 35 of the Law 2009. After this period radioactive waste must be transferred to licensed operating radioactive waste storage.

There is no spent nuclear fuel on territory of Republic of Serbia. The only nuclear fuel existing at the time of writing this Report in the Republic of Serbia is natural metal uranium rods placed in dry storage in reactor hall and LEU fuel elements TVR-S type in the core of the reactor RB. The burn-up level of fuel is very low due to low power. Once permanently removed from the reactor RB this fuel can be stored in Secure Storage. In 2010 all spent fuel from the research reactor RA was repatriated to the Russian Federation in the context of IAEA Russian research Reactors Fuel Return Programme.

A.7 Safety of spent fuel and radioactive waste

General safety requirements for safe management of spent fuel and radioactive waste are set out in the Law 2009 and respective bylaws as described in detail in Sections F, G and H.

Safety measures that need to be taken while performing radioactive waste management activities are prescribed by the Law 2009 and three rulebooks for implementation of this Law. Radioactive waste management is defined as nuclear activity. All provisions of the Law 2009 and respective bylaws related to the performance of the nuclear activities are also relevant for the radioactive waste management.

Obligatory part of the licencing documentation is safety assessment report. Under the current regulatory regime, SRPNA would assess any application for the licence for performing nuclear activity which includes management of spent fuel and radioactive waste. SRPNA would not licence the facility until the conditions for safety and security are fulfilled and until evidence is provided that facility does not present a hazard for the people and the environment.

A.8 Inventory of radioctive waste

Inventory of radioactive waste stored in new storage facilities, hangar H3 and secure storage is regularly maintained since start of their operation as well as inventory of liquid radioactive waste stored in hangar H0.

Inventory of radioactive waste stored in old storage facilities – hangars H1 and H2 and their vicinity, four underground liquid waste tanks - VR1, VR2, VR3 and VR4 and Radium Bunker is incomplete and only estimates based on former practices and partial records exist. Inventory of legacy waste in H0 is incomplete.

Inventory of radioactive waste is given in Section D.

A.9 Transboundary movement

Based on Article 2 of the Law 2009, it is forbidden to import radioactive waste and spent nuclear fuel of foreign origin on the territory of the Republic of Serbia.

There is no statement in national legislation regarding shipment of spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

Since the Law 2009 entered into force there are no activities regarding transit of radioactive waste and spent nuclear fuel of foreign origin in the Republic of Serbia

Republic of Serbia repatriated all fresh and spent nuclear fuel in 2002 and 2010 respectively to the country of origin – Russian Federation. These activities were done under IAEA's so-called Russian Research Reactors Fuel Return Programme. Detailed information on experiances gained during operation of transport of spent fuel is given in Section I.

A.10 Management of disused sealed sources

Disused sealed sources are not recognized in national legislation. There is no national strategy for the management of disused sealed radioactive sources. As imports of radioactive waste of foreign origin on the territory of the Republic of Serbia are forbidden by the Law 2009, thus this provision is also applicable to disused sealed radioactive sources declared as radioactive waste.

A.11 General efforts to improve safety

It is recognized that following actions will facilitate improvement of the legislative framework in Republic of Serbia:

- Adoption of the new Law in the field of radiation and nuclear safety and security
- Adoption of National Spent Nuclear Fuel and Radiaoctive Waste Management Policy and Strategy
- Adoption of strategic level document for the responsible and safe management of nuclear facilities

It is recognized that past practices resulted in generation of radioactive waste which was not managed in manner that would provide long term safety. Special attention has to be paid to the facilities on Vinča site and former uranium mine in Gabrovnica near Kalna. Ongoing and planned measures for improvement of radioactive waste management infrastructure are described in Section K.

Section B. Policies and Practices

Article 32. Reporting

1. In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:
   (i) spent fuel management policy;
   (ii) spent fuel management practices;
   (iii) radioactive waste management policy;
   (iv) radioactive waste management practices;
   (v) criteria used to define and categorize radioactive waste.

B.1 Spent fuel and radioactive waste management policy

Law 2009 foresees adoption of the Radioactive Waste Management Programme in line with the regulation on the strategic environmental impact assessment. This Programme shall serve to determine long-term plans and objectives regarding radioactive waste management in accordance with the standards and principles of the international organizations in these areas, as well as international commitments. This Programme forsees adoption of National Policy and Strategy of spent nuclear fuel and radioactive waste management in line with Council Directive 2011/70/Euratom and the IAEA recommendations. The Programme is still not adopted due to financial reasons.

Law banning construction of Nuclear Power Plants in SFRY was adopted in SFR Yugoslavia in 1989. After desintegration of SFR Yugoslavia the law containing the same provisions was adopted in FR Yugoslavia in 1995. In 2005, Parliament of Republic of Serbia put this Law into force on territory of Republic of Serbia. This Law foresees ban of construction of nuclear power plants, nuclear fuel fabrication plants and spent fuel reprocessing plants.

Adoption of new Law on radiation and nuclear safety and security is planned for the end of the first quarter of 2019. This new Law shall foresee adoption of national policy and strategy which will be in accordance with international standards and relevant EC directive. Basic elements for elaboration of national policy and strategy were prepared and discussed in 2017.

B.2 Spent fuel and radioactive waste management practice

Radioactive waste is stored on Vinča site since late 1940's on different locations and in different facilities. Until early 1990's all radioactive waste generated in former Yugoslavia was stored on this site. Radioactive waste generated in Republic of Montenegro was also stored on this site until desintegration of State Union of Serbia and Montenegro. All radioactive waste generated in Republic of Serbia nowdays is stored on this site. This waste originates from application of radioactive materials and sources in medicine, industry and research laboratories and former Yugoslav programme for development of nuclear technology. Since Vinča was the only radioactive waste management site, the amount of radioactive waste is significant.

Solid radioactive waste including spent sealed radioactive sources is stored in four storage facilities namely hangars H0, H1, H2 and H3 and Secure Storage for sealed radioactive sources. Liquid waste is stored in four underground liquid waste tanks namely VR1, VR2, VR3 and VR4.

Hangar H3 intended for storage of solid radioactive waste and Secure Storage intended for storage of spent sealed radioactive sources are operational. Other facilities are closed and do not accept radioactive waste. Radioactive waste that does not fulfil waste acceptance criteria for Hangar H3 can be temporarily kept in separate licensed facility – Hangar H0 until the infrastructure for treatment become available.

In Republic of Serbia radioactive waste is currently generated in medical, industrial and research activities. Besides operating storage facilities, radioactive waste can be kept by legal entity that generated this waste but no longer than one year according to the article 35 of the Law 2009. After this period radioactive waste must be transferred to licensed operating radioactive waste storage.

There is no spent nuclear fuel on territory of Republic of Serbia. The only nuclear fuel existing at the time of writing this Report in the Republic of Serbia is natural metal uranium rods placed in dry storage in reactor hall and LEU fuel elements TVR-S type in the reactor core of the reactor RB. The burn-up level of fuel is very low due to low power. Once permanently removed from the reactor RB this fuel can be stored in Secure Storage. In 2010 all spent fuel from the research reactor RA was repatriated to the Russian Federation in the context of IAEA Russian Research Reactors Fuel Return Programme.

B.2.1 Legacy waste facilities

Legacy radioactive waste in Serbia is non-treated solid waste in old storage facilities H0, H1, H2 and Radium Bunker and liquid waste stored in four underground tanks VR1-VR4, all situated on the Vinča site.

At the beginning, solid radioactive waste generated in whole Yugoslavia was stored in standardized steel drums and buried in shallow repository in the center of the Vinča site. Later, purpose of this location was changed and drums was transferred to new location near current hangar H2 where it was stored in open space and subsequently moved to storage facility H2 during the 1980's. Pictures of radioactive waste from open space near Hangar H2 is given in Figure 10, Figure 11 and Figure 12.

Radioactive waste generated in first two decades since establishment of Vinča Institute originated from industrial, medical and research activities. Such radioactive waste demanded measures for safe and secure storage which resulted in construction of first radioactive waste storage facility - Hangar H1 in 1968. This facility accepted radioactive waste until 1982 when it was closed due to high dose rates in several areas inside. By that time new storage facility Hangar H2 was built and it started accepting radioactive waste in 1984. This facility accepted radioactive waste until 2012 when it was closed due to lack of storage space. Beside operation of Hangar H2, certain amount of radioactive waste was placed occasionally inside hangar H1 until 1990's.

Hangar H0 was originally built for storage of sealed radioactive sources. Radium sources used from the beginning of operation of Vinča Institute are stored in so called Radium Bunker. Liquid radioactive waste from operation in research reactor RA and activities in Laboratory of Chemical Dynamics is stored in four underground tanks VR1-VR4.

Figure 10. Radioactive waste stored in open space in 1980's

Figure 11. Radioactive waste stored in open space in 1980's

Figure 12. Radioactive waste stored in open space in 1980's

B.2.1.1 Hangar H0

Hangar H0 is a bunker built in the vicinity of Laboratory for Radioisotopes and research reactor RA. Picture of the entrance to Hangar H0 is given in Figure 13. Originally it was used as a temporary storage for sealed radioactive sources. Sealed radioactive sources and contaminated items from previous activities are still stored inside hangar H0.

Figure 13. Hangar H0

B.2.1.2 Hangar H1

Hangar H1 presented in Figure 14 is metallic hangar with dimensions 32.5 m×15.4 m on concrete floor built in 1968. This hangar accepted radioactive waste and sealed radioactive sources until 1982 when it was closed due to high dose rates. Certain amount of radioactive waste was placed occasionally inside this hangar until 1990's. Taking into account condition of its structures, stored radioactive waste, lack of information on its inventory, extent of contamination inside and dose rates, Hangar H1 is generally in unsatisfactory condition. Inspection of radioactive waste stored inside is not possible. The situation in and around hangar H1 can be described as not satisfactory from a safety point of view. Radioactive waste is packed in different types of containers some of which are improper, heavily corroded or damaged. Pictures of radioactive waste stored inside Hangar H1 are given in Figure 15 and Figure 16. Approximate inventory of radioactive waste stored in Hangar H1 is given in Section D.

Figure 14. Hangar H1

Figure 15. Radioactive waste stored inside Hangar H1

Figure 16. Radioactive waste stored inside Hangar H1

B.2.1.3 Hangar H2

Hangar H2 presented in Figure 17, with dimensions 37.5 m×10.5 m, was built in 1982 and accepted waste until 2012 It consists of two parts: metallic part intended for storage of radioactive waste and concrete part initially intended for waste processing. Waste processing activities were never done in concrete part of hangar. Capacity of Hangar H2 is completely filed. Low level waste and sealed radioactive sources were accepted for storage. No significant spread of contamination inside is present and construction of the hangar is in satisfactory condition. The radioactive waste in Hangar H2 is packed in standard 200 liter drums, positioned vertically in several rows of different height. Visual inspection shows some heavily corroded drums, what could be also indication of possible contamination. Pictures of radioactive waste stored inside Hangar H2 are given in Figure 18 and Figure 19. Approximate inventory of radioactive waste stored in Hangar H2 is given in Section D.

Figure 17. Hangar H2

Figure 18. Radioactive waste stored inside Hangar H2

Figure 19. Radioactive waste stored inside Hangar H2

B.2.1.4 Containers C1 and C2

In order to storage radioactive waste that will be generated in preparatory activitis for spent fuel repackaging, two metallic containers were constructed next to existing storage facilities hangars H1 and H2. In the begining of 2007, activity of cutting and dismantling of underwater metallic construction in spent fuel storage pool at research reactor RA was performed. Waste arisen from these operations is stored in container C1. Picture of radioactive waste stored inside container C1 is given in Figure 20.

Dismantled radioactive lightning rods are stored in container C2. Picture of container C2 is given in Figure 21.

Figure 20. Radioactive waste stored inside container C1

Figure 21. Container C2

B.2.1.5 Underground liquid waste tanks

Four underground tanks were used for storage of liquid radioactive waste generated during operation of the research reactor RA and Laboratory for Chemical Dynamics of Vinča Institute. These tanks were constructed at the same time as the research reactor RA and they are connected to it by underground piping. Picture from the time of construction is given in Figure 22. Layout of underground waste tanks and associated piping is given in Figure 23. Tanks are made of concrete with stainless steel liner. Each of them has volume of 400m^3. Approximate inventory of radioactive waste stored in these tanks is given in Section D.

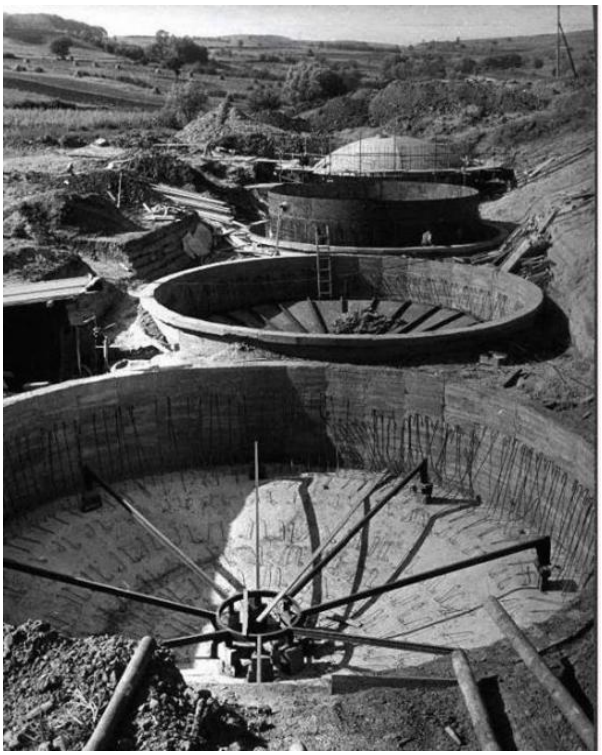

Figure 22. Underground liquid waste tanks during construction

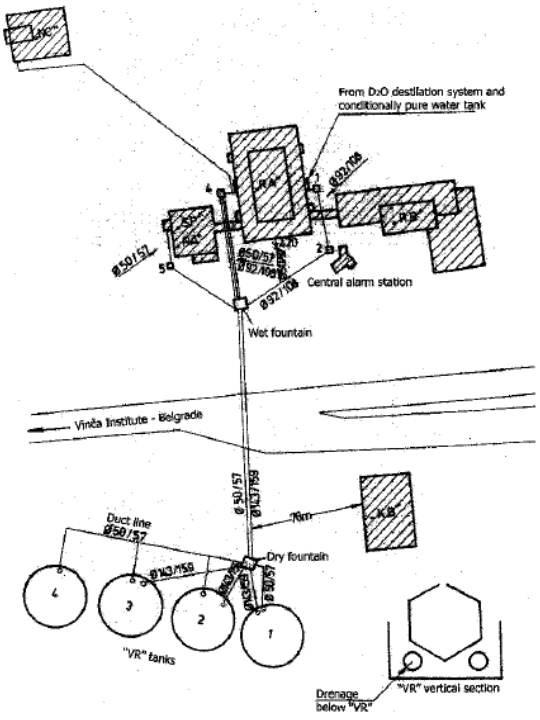

Figure 23. Layout of underground liquid waste tanks and piping

B.2.1.6 Radium Bunker

Repackaging of radium sources at Vinča Institute was performed in facility called Radium Pavilion built in 1951 [2]. After activities in this facility ended in 1962 all materials were transferred to so-called Radium Bunker. Picture of Radium Pavilion and Radium Bunker is given in Figure 24. Various forms

of radium sources, with estimated weight of 7 g are stored in Radium Bunker. This is concrete facility constructed on the ground level covered with lead plates. During NATO bombing in 1999, additional concrete bunker without entrance, was constructed surrounding existing bunker and covered with soil. In 2009 responsibility for management of Radium Bunker were transfered from Vinča Instutte to PC NFS.

Figure 24. Radium Pavilion and Radium Bunker

B.2.2 Current waste management practices

By the beginning of the 21st century it became clear that existing storage facilities cannot provide enough space for activities planned in the near future. These activities covered decommissioning of the research reactor RA, processing of waste stored in existing waste storages hangars H0, H1 and H2, underground liquid waste tanks VR1 - VR4, decontamination and potential decommissioning of these facilities and subsequent remediation of their locations. Because of this, new storage facilities for radioactive waste – Hangar H3 and Secure Storage for sealed radioactive sources were constructed in period from 2007 until 2010.

B.2.2.1 Hangar H3

Radioactive waste can be stored in Hangar H3. This storage which is shown on Figure 25 was built between 2007 and 2010. It is licensed to accept up to 4363 standard 200 liter drums, 32 Half Length – Half Height standard ISO containers and 8 standard ISO containers. Hangar H3 is built as concrete structure with dimensions 48 m×26 m and equipped with ventilating and auxiliary power systems, dose monitoring equipment and equipment for waste packages manipulation. Facility accept radioactive waste since 2012. Picture of interior of Hangar H3 is given in Figure 26.

Figure 25. Hangar H3

Figure 26. Interior of Hangar H3

B.2.2.2 Hangar H0

After the Hangar H3 was put into operation, it was concluded that there is a need for storage space for radioactive waste that does not fulfill waste acceptance criteria for H3. Based on analyses performed and upgrades of the facility, part of the Hangar H0 is licenced to accept such radioactive waste since 2013. One room in hangar H0 is now used for temporary keeping of up to 900 liters of liquid radioactive waste as shown in Figure 27.

Figure 27. Liquid radioactive waste kept in Hangar H0

B.2.2.3 Secure storage

Spent sealed radioactive sources are stored in secure storage for sealed sources built between 2007 and 2010 adjacent to Hangar H3. Secure Storage is built as concrete structure with dimensions 16.1 m×26 m and equipped with ventilating and auxiliary power systems, dose monitoring equipment and equipment for source containers manipulation. Facility accept spent sealed radioactive sources since 2012. Racks and containers for storage of sealed radioactive sources are given in Figure 28 and Figure 29.

Figure 28. Racks for storage of sealed radioactive sources

Figure 29. Containers for storage of sealed radioactive sources

B.2.2.4 Processing of radioactive waste

Radioactive waste is currently not processed in Serbia and there are ongoing activities on establishment of radioactive waste processing facility. This facility will enable segregation, compaction and solidification of radioactive waste as well as conditioning of spent sealed radioactive sources of Cat. III, IV and V. Limited number of sealed radioactive sources Cat. I and II will be conditioned in the hot cells of the research reactor RA.

B.2.3 Radioactive waste and spent nuclear fuel inventory

Information on radioactive waste inventory are summarized in chapter D. Currently, there is no spent nuclear fuel on the territory of Republic of Serbia.

B.3 Criteria used to define and categorize radioactive waste

B.3.1 Definitions

The definition of radioactive waste according the Law 2009 is:

> *Radioactive waste* is a radioactive material which is not intended for further use.

The definition of spent nuclear fuel according to Rulebook RWM is:

> *Spent nuclear fuel* means the nuclear fuel, irradiated and permanently removed from a nuclear reactor's core; spent nuclear fuel may be deemed a usable resource to be processed or permanently disposed without any further use and in that case it is treated as radioactive waste.

B.3.2 Categorization

The categorization of radioactive waste is given in Rulebook RWM. Categorization is done according IAEA GSG-1 "Classification of Radioactive Waste". Radioactive waste is categorized in six categories given in Table 1.

Table 1. Categorization of radioactive waste

Category	Typical characteristics and disposal method
Exempt waste EW	Specific activity concentration or total activity in radioactive waste is equal to or lower than the required levels for exception or clearance from regulatory control.
Very short lived waste VSLW	Waste that can be stored for decay over a limited period of up to a few years and subsequently cleared from regulatory control according to approval of the SRPNA, for uncontrolled disposal, use or discharge. This class includes waste containing primarily radionuclides with very short half-lives usually used for research and medical purposes.
Very low level waste VLLW	Waste that does not necessarily meet the criteria of exempt RAW (EW), but that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near surface disposals with limited regulatory control. Such disposals may also contain other hazardous waste. Typical waste in this class includes soil and rubble with low levels of activity concentration. Concentrations of longer lived radionuclides in VLLW are generally very limited.
Low level waste LLW	Waste that is above clearance levels, but with limited amounts of long lived radionuclides. Such waste requires isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near surface facilities. This class covers a very broad range of waste. LLW may include short lived radionuclides at higher levels of activity concentration, and also long lived radionuclides, but only at relatively low levels of activity concentration.
Intermediate level waste ILW	Waste that, because of its content, particularly of long lived radionuclides, requires a greater degree of containment and isolation than that provided by near surface disposal. However, ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. ILW may contain long lived radionuclides, in particular, alpha emitting radionuclides that will not decay to a level of activity concentration acceptable for near surface disposal during the time for which institutional controls can be relied upon. Therefore, waste in this class requires disposal at greater depths, of the order of tens of metres to a few hundred metres.
High level waste HLW	Waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long lived radionuclides that need to be considered in the design of a disposal facility for such waste. Disposal in deep, stable geological formations usually several hundred metres or more below the surface is the generally recognized option for disposal of HLW.

Section C. Scope of Application

Article 3: Scope of application

1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.
2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.
3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.

C.1 Safety of spent fuel management

There is no spent nuclear fuel on territory of Republic of Serbia. In 2010 all spent fuel from the research reactor RA was repatriated to the Russian Federation in the context of IAEA Russian Research Reactors Fuel Return Programme. In accordance with Article 5, para. 3 of the Agreement between the Government of Republic of Serbia and Government of Russian Federation concerning cooperation in the Import of Irradiated Nuclear Fuel from a Research Reactor into the Russian Federation **no products** generated by the reprocessing of the irradiated nuclear fuel including generated uranium and plutonium and radioactive waste, shall be returned to the Republic of Serbia.

Construction of facilities for reprocessing of spent fuel is forbidden in the Republic of Serbia under provisions of the Law banning construction of nuclear power plants. Thus reprocessing is not performed in Republic of Serbia.

C.2 Safety of radioactive waste management

C.2.1 Safety of radioactive waste resulting from civilian applications

Law 2009 defines that nuclear activities are import, export, use and transport of a nuclear material, exploitation of ores containing a nuclear material, locating, designing, construction, trial run, commissioning, use, permanent shut-down and decommissioning of nuclear facilities and remediation of their sites, as well as radioactive waste management. Safety measures that need to be taken while performing radioactive waste management activities are prescribed by the Law 2009 and three rulebooks for implementation of this Law namely:

- Rulebook on Performance of Nuclear Activities
- Rulebook on Conditions for Obtaining Licence to Perform Nuclear
- Rulebook on Radioactive Waste Management

Article 46 of the Law 2009 prescribes that nuclear safety and security measures undertaken for all activities regarding nuclear facilities, nuclear materials, radioactive waste, as well as in case of an accident are:

1) provision of the conditions for locating, designing, construction, trial run, commissioning, use, permanent shut-down and decommissioning of nuclear facilities;
2) fulfilment of the criteria for nuclear facility safety evaluation;
3) provision of the conditions for trade and use of nuclear materials;
4) provision and implementation of radiation protection measures in a nuclear facility and its vicinity;
5) stipulating the required conditions to be met by the people working in a nuclear facility;
6) provision of the conditions for collecting, recording, treating, storing and disposing of radioactive waste;
7) physical protection of a nuclear facility;
8) prevention of illicit trafficking of nuclear materials;
9) provision of the conditions for implementing the Action Plan in Case of an Accident.

Article 63 of the Law 2009 prescribes that the licensee for performing a radiation practice or licensee for performing a nuclear activity undertakes to collect, keep, record and store radioactive waste in the prescribed manner and conditions. The licensee undertakes to:

1) ensure that the buildings and premises where radioactive waste is collected, kept, recorded and stored meet the technical, safety and other required conditions ensuring the protection of people and the environment from ionising radiation;
2) implement the measures preventing radioactive waste to cause the environmental contamination;
3) secure the stored radioactive or nuclear material.

Article 49 of the Law 2009 prescribes that nuclear facility may be located, designed, built, put into the trial run, commissioned, used, permanently shut-down and its decommissioning launched only with a previously obtained licence for performing a nuclear activity. The license may be issued after it has been established that all required nuclear safety measures have been met, based on the nuclear safety report and other required documentation.

C.2.2 Waste that contains only naturally occurring radioactive material

Law 2009 defines radioactive waste as radioactive material which is not intended for further use. The same Law defines radioactive material as material containing one or several radionuclides whose total and specific activities are above the prescribed limits. These limits are prescribed in Rulebook on Notification and Registration of Radiation Sources (Official Gazette RS 25/11). Waste that contains only naturally occurring radioactive material is declared as radioactive waste only if it fulfils condition setout in this Rulebook.

C.3 Military or defence programmes

All safety measures prescribed by the Law 2009 are also applicable to management of radioactive waste that originates from military or defense programmes.

Section D. Inventories and Lists

Article 32 (Reporting), paragraph 2

2. This report shall also include:

(i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

(ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

(iv) an inventory of radioactive waste that is subject to this Convention that:

(a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

(b) has been disposed of; or

(c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

(v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1 Spent fuel management facilities

There are no spent fuel management facilities in Republic of Serbia.

D.2 Inventory of spent fuel

There is no spent fuel in Republic of Serbia. The only nuclear fuel in Serbia is the fuel from the RB Reactor. This fuel, once permanently removed from the reactor core will be the only spent fuel in Republic of Serbia. This fuel has very low burn-up due to low power of the Reactor RB. Nevertheless, once this fuel is permanently removed from the reactor core, safety and security measures have to be in place. The number of items and mass of fuel is in accordance with Safeguards declaration.

D.3 Radioactive waste management facilities

D.3.1 Existing radioactive waste management facilities

Detailed description of all radioactive waste management facilities in Republic of Serbia is given in Section B.

Solid radioactive waste is stored in four separate storage facilities namely H0, H1, H2 and H3. Spent sealed radioactive sources are stored in Secure Storage. Legacy radium sources are stored in so-called Radium Bunker. Liquid radioactive waste is stored in four underground liquid waste tanks namely VR1 – VR4. Facilities H0, H3 and Secure Storage are licensed for operation. Activities that will ensure safe removal of radioactive waste stored in old storage facilities H1 and H2 are also licensed.

D.3.2 Planned radioactive waste management facilities

Existing situation with waste stored in storage hangars H1 and H2 lead to decision on construction of radioactive waste processing facility. Lack of developed waste processing facility that will be able to manage all on-site stored waste and spent sealed radioactive sources is crucial reason why waste is still not treated. During the process of planning of construction of the new waste storage facilities in 2007-2008, construction of new and modern waste processing facility has been foreseen. However, lack of financial resources led to the decision to refurbish existing building on the site, close to the new waste storage Hangar H3.

Refurbishment of the facility is done under IAEA TC project SRB3004 in 2016. Waste Processing Facility[12] still does not have neither civil license for use nor nuclear license.

Activities that will take place in WPF are: characterization, segregation, compacting, drying, dismantling of smoke detectors and conditioning of sealed radioactive sources Cat. III and IV.

Management of radioactive waste in WPF will be organized in the following way:

1. Acceptance of the waste drum or container;
2. Pre-characterization measurements;
3. Sorting, segregation and repackaging in the ventilated tent;
4. Decontamination;
5. Dismantling;
6. In-drum compaction
7. Repackaged drum towards the dispatch area;
8. Dispatching of the repackaged drum towards the final characterization area and H3 storage facility.

The flowchart given in Figure 30 describes the different flows to be followed in the processing of radioactive waste.

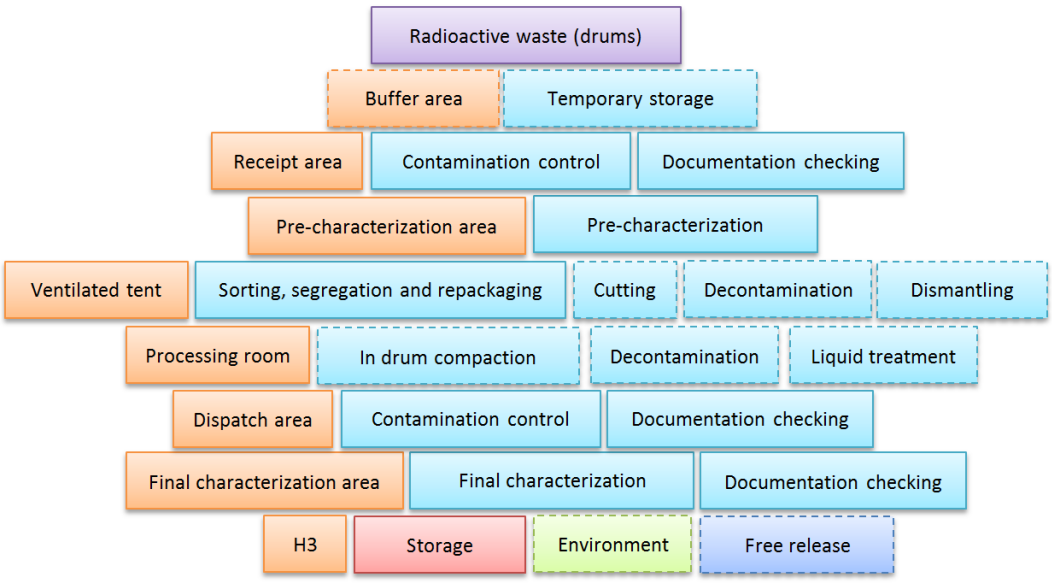

Figure 30. Flowchart of the processing of radioactive waste

[12] In the text below: WPF

The management of sealed radioactive sources in the WPF can be represented by the following steps:

1. The sealed radioactive sources will be regrouped at the place where they are currently stored in order to treat them by batches, and transported by forklift to the WPF;
2. Identification of the source or determination of the radioisotope (by label identification and/or measurements);
3. Confirmation of the identification of the source (by measurements);
4. Leak control;
5. Dismantling;
6. Segregation of contaminated parts and parts proposed for clearance in respective drums;
7. Dispatching of the drums towards the final characterization area and H3 storage facility.

In the case of a leaking source it will be conditioned in the research reactor RA hot cells.

The flowchart given in Figure 31 describes the different flows to be followed in the processing of the sources.

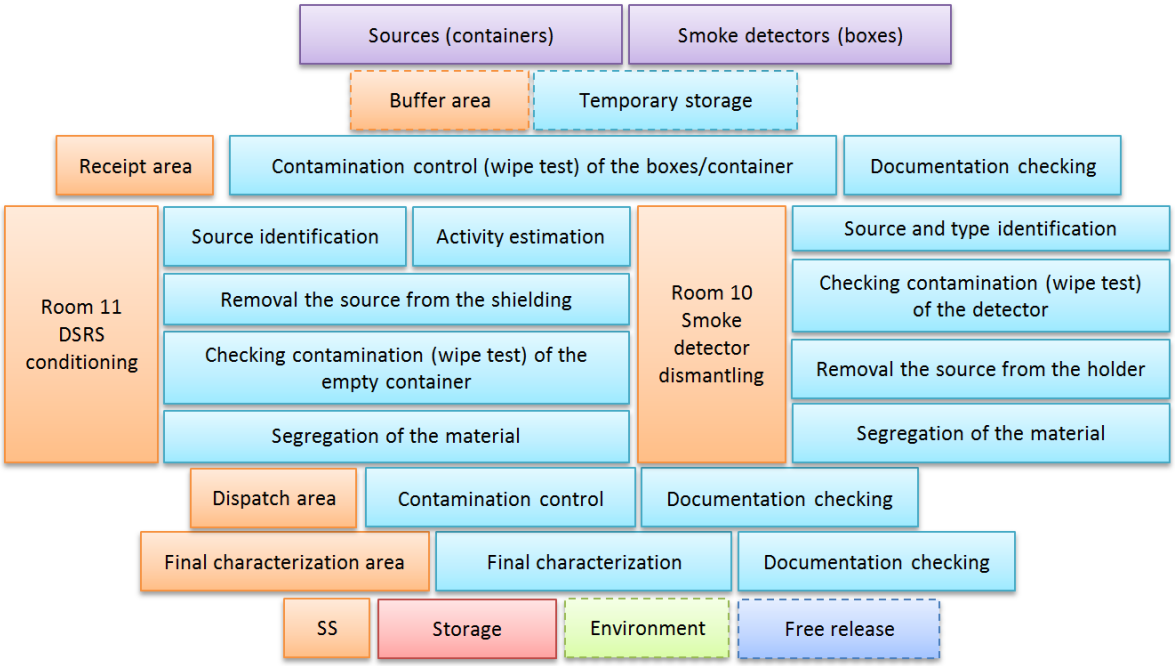

Figure 31. Flowchart of the processing of sealed radioactive sources and smoke detectors

D.4 Inventory of radioactive waste

Inventory of radioactive waste stored in new storage facilities Hangar H3 and Secure Storage is regularly updated since start of their operation as well as inventory of liquid radioactive waste stored in Hangar H0.

Inventory of radioactive waste stored in old storage facilities – hangars H1 and H2 and their vicinity, four underground liquid waste tanks - VR1, VR2, VR3 and VR4 and Radium Bunker is incomplete. Only estimates based on former practices and partial records are available. Inventory of legacy waste in Hangar H0 is incomplete.

D.4.1 Inventory of radioactive waste in new storage facilities

According to issued licences for operation of radioactive waste storage H3 and H0 and Secure storage and based on data inserted into CWID database managed by PC NFS information on stored radioactive waste and sealed sources since 2012 is:

- Total amount of solid low level waste stored in Hangar H3 is 31.8 m^3. Radionuclides present in this radioactive waste are ^{137}Cs, ^{226}Ra, ^{238}U, ^{232}Th, ^{3}H, ^{241}Am, ^{60}Co and ^{90}Sr.
- Total amount of liquid low level waste stored in Hangar H0 is 0.37 m^3. Radionuclides present in this radioactive waste are ^{137}Cs and ^{3}H.
- One Cat. I ^{60}Co teletherapy source is stored in Secure Storage.
- Total number of 454 Cat. III and IV sources is stored in Secure Storage. These sources contain ^{137}Cs, ^{226}Ra, ^{85}Kr, ^{232}Th, ^{241}Am, ^{60}Co, $^{152,154}Eu$, ^{90}Sr and $^{241}Am/Be$ neutron sources.
- Total number of Cat. V sources stored in Secure Storage is 16. These sources contain ^{3}H, ^{68}Ge, ^{63}Ni, ^{137}Cs and ^{90}Sr.
- Total number of Cat. V sources from military compasses with radium paintings is 10016. These sources are stored in Hangar H3.
- Total number of Cat. V ^{241}Am sources from ionizing smoke detectors stored in Hangar H3 is 9269.

Inventory of radioactive waste in new storage facilities is given in Table 3 and Table 4 in Annex L.1.

D.4.2 Inventory of radioactive waste in old storage facilities

Estimated volume of radioactive waste stored in hangar H0, hangars H1, H2 and theris suroundings, underground liquid waste tanks and Radium Bunker are given in this chapter. Because there is no detailed inventory of radioactive waste in these facilities, figures should be understood as approximate. These estimations are based on data given in Radioactive Waste Management Strategy of Vinča Institute from 2008 [3] and safety analyses reports for hangars H1 and H2 [5].

D.4.2.1 Approximate inventory in Hangar H1

Approximate inventory of radioactive waste and spent sealed radioactive sources in Hangar H1 is given in Table 5 in Annex L.1. This inventory can be divided in several main groups as follows.

Radioactive waste from different users

Non-segregated operational waste that originates mainly from the laboratories of the Vinča Institute, and also from medical institutions and biological laboratories from the former Yugoslavia.

Technological, irradiation and ventilation channels

Technological, irradiation and ventilation channels were contaminated during operation of the research reactor RA. Technological channels consist of an inner and an outer pipe, each of them 6 m long and made of aluminum. The inner pipe is of 43 mm in diameter, the wall thickness is 1 mm. The outer pipe is of 65 mm in diameter, the wall thickness is 9.5 mm. There is no data available about the irradiation and ventilation channels. It is assumed that they were made of stainless steel.

Yellow cake

Yellow cake originated from Institute for Technology of Nuclear and other Mineral Row Materials is stored in plastic bags and plastic containers.

Radioactive waste from the Laboratory for Reactor Material Sciences

Radioactive waste generated during the metal uranium processing (cutting, equipment decontamination, etc.) in the Laboratory for Reactor Material Sciences of Vinča Institute is in Hangar H1. According to

the available records, only six drums contain total of 105 kg metallic uranium. Other drums do not contain pure metallic uranium and were received from the Laboratory for Reactor Material Sciences as waste containing traces of uranium, coveralls, waste boric oils, cotton pads, rubber gloves, considering as non-safeguards wastes.

Transuranic liquid waste

Transuranic liquid waste containing traces of ^{241}Am and ^{239}Pu mostly in 5 liter, 10 liter, 25 liter, few glass bottles of 30 liter and few 50 liter plastic containers and several grams of ^{239}Pu in the form of nitric acid solution in two stainless-steel containers 20 liter each are stored in Hangar H1. The total number of containers is 39. These containers have been packaged in 1985 into 20 standard 200 liter drums. The total amount of plutonium is 6.7g. It is estimated that total amount of liquid wastes in these containers has a volume of 300 liters.

Waste from Laboratory for Radioisotopes

Radioactive waste packed in 105 standard 200 liter drums, filled with concrete, from the Laboratory for Radioisotopes is stored in Hangar H1. Additional 4 standard 200 liter drums filled with concrete from the same origin, are stored outside Hangar H1 which makes a total number of 109 standard 200 liter drums. The activity per drum is estimated at a maximum of 37 GBq with expected considerable variations between the drums.

Glove boxes

Contaminated stainless steel glove boxes from the Laboratory for Chemical Dynamics are stored in Hangar H1.

Radioactive sources

About 300 ^{60}Co and ^{137}Cs spent sealed radioactive sources, about 200 Cat. IV spent sealed radioactive sources from lightning rods and about 200 other spent sealed radioactive sources are stored in Hangar H1.

D.4.2.2 Approximate inventory in Hangar H2

Approximate inventory of radioactive waste and spent sealed radioactive sources in Hangar H2 is given in Table 6 in Annex L.1. This inventory can be divided in several main groups as follows.

Radioactive waste from former open repository

About 1000 standard 200 liter drums with a compacted and repacked radioactive waste from the former open repository is stored in Hangar H2. These wastes consist of scrap metal and soil. The average activity per drum is about 185 MBq.

Air filters gathered after Chernobyl accident

About 300 standard 200 liter drums with air filters gathered after the Chernobyl accident are stored in Hangar H2. The radioactivity per drum is small but still above prescribed clearance levels.

Radioactive waste from various users

About 450 standard 200 liter drums with radioactive waste from various users are stored in Hangar H2. This waste originates mainly from the laboratories of the Vinča Institute, and also from medical institutions and biological laboratories from the former Yugoslavia. The activity is assumed to be very low, about 37 kBq per drum.

Solidified sludge from the reactor pool

31 standard 200 liter drums with solidified sludge from the reactor pool are stored in Hangar H2. The average activity per drum is 148 MBq.

Spent sealed sources from radioactive lightning rods

At least 625 spent sealed sources of ^{152,154}Eu, 300 spent sealed sources of ^{60}Co from radioactive lighting rods are stored in three shielded 200 liter containers. The total activity inside the containers is 22.2 TBq. Two of these shielded containers are given in Figure 32.

Figure 32. Shealded containers for storage of spent sealed sources from radioactive lightning rods

Depleted uranium

Currently, three metal containers containing about 300 depleted uranium bullets, two metal containers with aluminum bullet shells contaminated with depleted uranium, seven metal containers with a mixture of bullets and shells and 15 200 liter drums with soil contaminated with depleted uranium are stored in hangar H2. Waste was collected during decontamination activities on sites contaminated due to NATO bombing of territory of Republic of Serbia and Republic of Montenegro with the ammunition with depleted uranium in 1999. Picture of containers for storage of depleted uranium is given in Figure 33.

Figure 33. Depleted uranium

Metal pipes and scrap metal

Two metal pipes contaminated with radium are stored in H2. The diameter of the pipes is 250mm and they are about 2m long. Eight metal barrels containing scrap metal contaminated with radium are stored in H2.

Radioacitve waste from spent fuel repackaging operation

Radioacitve waste generated during spent fuel repackaging operation is stored in 25 stailess steel containers with volume of 77 liter each. These drums are overpacked in standard 200 liter drums filled with sand to reduse dose rates as showin in Figure 34. Waste in 77 liter containers is mainly aluminum barrels and pipes used for storage of spent fuel in spent fuel pool. Detailed inventory of this radioactive waste exists.

Figure 34. Radioacitve waste from spent fuel repackaging operation

Compressible operational waste from spent fuel repackaging operation

Compressible operational waste from spent fuel repackaging operation in 2010 consisting of protecting equipment (gloves, overcoats, overshoes etc.) is stored in hangar H2. This waste is stored in 400 standard 200 liter drums. This waste is mainly contaminated with ^{60}Co and ^{137}Cs. Picture of this waste is shown in Figure 35.

Figure 35. Compressible operational waste from spenjt fuel repackaging operation

Contaminated metal waste and soil

110 drums containing very low level metal waste and 110 drums containing soil contaminated with ^{137}Cs is stored in Hangar H2.

Cat. V sources from smoke detectors

More than 100.000 ionizing smoke detectors containing ^{241}Am, ^{85}Kr, ^{226}Ra sources of Cat.V are stored in Hangar H2. These detectors are stored in plastic boxes given in Figure 36.

Figure 36. Plastic boxes with ionizing smoke detectors

Industrial spent sealed radioactive sources

Approximately 800 spent sealed radioactive sources used in industrial applications are stored in original containers in Hangar H2 as shown in Figure 37.

Figure 37. Industrial spent sealed radioactive sources

D.4.2.3 Approximate inventory of radioactive waste in surroundings of hangars H1 and H2

Approximate inventory of radioactive waste in surroundings of hangars H1 and H2 is given in Table 7 in Annex L.1. This inventory can be divided in several main groups as follows.

Contaminated metal waste in ISO containers

Contamianted metal waste is stored in 12 metal ISO containers. This radioactive waste consists of metal waste contaminated with ^{226}Ra, contaminated metal waste from former uranium mine in Gabrovnica, contaminated laboratory equipment and equipment contamined during repackaging of spent nuclear fuel.

Contaminated metal waste from spent fuel pool in container C1

Metal structures contaminated with ^{60}Co and ^{137}Cs, retrieved from the spent fuel pool during preparation for spent fuel repackaging are stored in metal boxes of different dimensions. These boxes are placed in

contaner C1 next to Hangar H1. Detail records of this waste exist. Example of contaminated metal structure stored in container C1 is shown on Figure 38.

Figure 38. Contaminated metal structure stored in container C1

Spent sealed sources from radioactive lightning rods in annex C2

Spent sealed sources from radioactive lightning rods are placed in container C2 next to Hangar H2. Some of these sources are stored in small colective lead containers which can hold up to 5 sources. Certain number is still in its original holder.

D.4.2.4 Approximate inventory of radioactive waste in underground liquid waste tanks

Underground liquid waste tanks VR-1, VR-2 and VR-3 are connected with reactor RA through a special channel system made of stainless steel. Tank VR-4 is connected with the Laboratory for chemical dynamics of Vinča Institute. Total amount of liquid radioactive waste stored in these tanks is about 869.8 m^3 as shown in Figure 39 and given in Table 8 in Annex L.1.

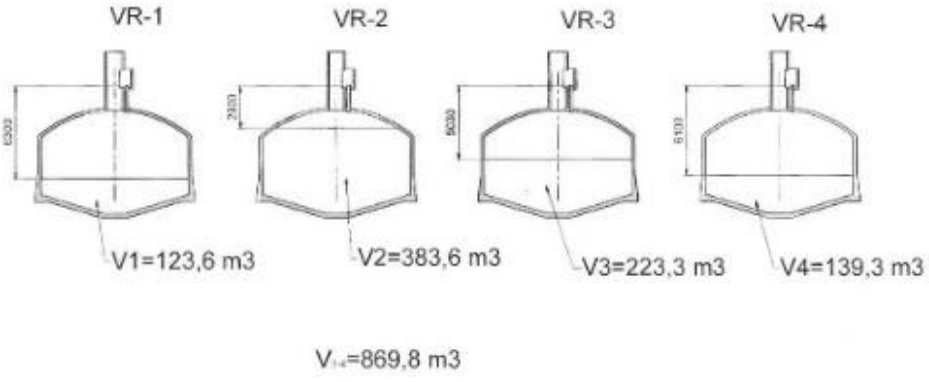

Figure 39. Liquid radioactive waste stored in underground tanks

The radioactivity in the tanks VR-1 and VR-2 consists mainly of ^{60}Co, which originated from the 1963 accident, when the heavy water system of the reactor RA became contaminated with ^{60}Co. The activity level in the effluents is about 4×10^3 Bq/ml. The decontamination agents were different depending on the contaminated material. The principal components of these agents were solutions of phosphoric, chromic and nitric acids, which are responsible for the high content of anions and cations presented in

Table 2. During decontamination activities about 1000 mg/l of organic acids and detergents also got into the effluents.

The major part of the effluents activity, beside ^{60}Co, comes from radionuclides ^{137}Cs and ^{90}Sr.

According to the latest measurements, performed in 1986, the specific activity of the effluents was 4.24×10^{9} Bq/m^3. The effluents are yellow-brownish, highly acidic (pH=1.55), with the density of 1.0106 gr/cm^3. The amount of dry residue which includes materials of both organic and inorganic origin is 12.3 g/l.

Table 2. The content of principal anions and cations present in the VR-1 tank

Anions and cations	**Concentration [mg/l]**
PO_4^{3}	2700
CrO_4^{2}	2200
NO_3	1600
Fe^{3+}	11
Ni^{2+}	3
Al^{3+}	12
Ca^{2+}	60
Na^{+}	290
Mg^{2+}	10

D.4.2.5 Approximate inventory of radioactive waste in Radium Bunker

Radium sources with a content of about 7g of ^{226}Ra are stored in a bunker on the Vinča site as given in Table 9 in Annex L.1.

D.4.2.6 Approximate inventory of legacy radioactive waste in H0

Hangar H0 was used for temporary storage of sealed radioactive sourcesused in Laboratory for Radioisotopes of Vinča Institute. Contaminated ventilation channels from Laboratory for Chemical Dynamics of Vinča Institute are also stored in this facility. Inventory of stored radioactive waste is unknown due to the lack of records. Approximate inventory is given in Table 10 in Annex L.1. Panoramic view of room in H0 with legacy waste is given in Figure 40.

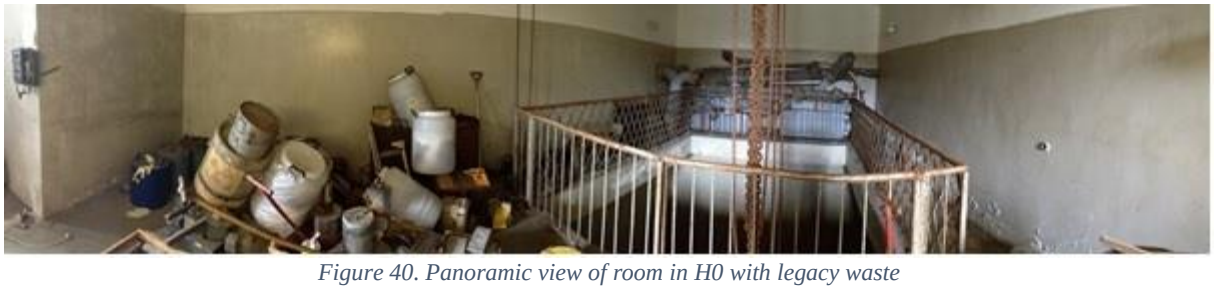

Figure 40. Panoramic view of room in H0 with legacy waste

D.5 Facilities in the process of being decommissioned

D.5.1 Research reactor RA

During the period of extended shutdown since 1984 some reactor systems are partially or fully dismantled, planned reconstruction and modernization has never been finished, significant loss of experienced personnel and lack of utilization programs have happened. Problems with inadequate conditions of the water in the pools used as the temporary storage of spent fuel in research reactor RA building arrise during the years.

General conditions of research reactor RA and its systems, lack of both interest and support for the continuing of operation, loss of operational staff, spent fuel problems are basic facts which made real the assumption about the near decommissioning as very probable option for the permanent solving of the future facility status. After the renewal of FR Yugoslavia's membership in the IAEA in 2001, Vinča Institute proposed the project "Decommissioning of research reactor RA in Vinča Institute" through the IAEA Technical Co-operation Program. At the same time, the proposal to both Federal and Republic Governments was sent to bring decision about the final shutdown of research reactor RA. It was proposed to begin preliminary administrative and technical actions needed for the start of decommissioning process. RA decommissioning project has been supported by the IAEA through national TC project. Governments of FR Yugoslavia and Republic of Serbia brought decisions in July 2002 about the final shutdown of RA and the transport of fresh HEU fuel from the RA and RB reactors in Vinča and also all spent LEU and HEU fuel elements to the country of origin – Russian Federation. Transport of fresh fuel was conducted in August 2002 and transport of spent fuel was completing in December 2010. Preparation of the decommissioning was partially done and radiological characterization of components and materials, radiation levels and contamination mapping inside the reactor facility was mostly done before repackaging of spent nuclear fuel. Since shipment of spent nuclear fuel, no decommissioning activities were performed on the research reactor RA.

D.5.2 Hangars H1 and H2

The current situation of the hangar H1 is unacceptable from the point of radiation safety. The level of damage of building structures, extent of contamination inside the hangar and condition of the waste makes it impossible to achieve the required level of safety of the waste by the smaller repairs and improvements. After retrieval of all radioactive waste from Hangar H1, decision will be made upon their future destiny. From current point of view, decommissioning is most probable option.

No significant spread of contamination inside the Hangar H2 is present, construction of the building is in good condition and ensures the protection of radioactive waste from atmospheric precipitation and animal intrusion. After retrieval of all radioactive waste from Hangar H2, detail radiological characterization and inspection of facility construction and structures, decision will be made upon their future destiny.

Section E. Legislative and Regulatory System

E.1 Implementing measures

Article 18. Implementing measures

Each Contracting Party shall take, within the framework of its national Act, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

The legislative, regulatory and other measures taken to fulfil the obligations of the Convention are discussed in this Report.

E.2 Legislative and regulatory framework

Article 19: Legislative and regulatory framework

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.
2. This legislative and regulatory framework shall provide for:
   (i) the establishment of applicable national safety requirements and regulations for radiation safety;
   (ii) a system of licensing of spent fuel and radioactive waste management activities;
   (iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a license;
   (iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;
   (v) the enforcement of applicable regulations and of the terms of the licenses;
   (vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.
3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

E.2.1 Safety of spent fuel and radioactive waste management

In the Republic of Serbia is in force the Law on banning the construction of nuclear power plants (Official Gazette of FRY 12/95 and Official Gazette RS 85/05). Under that Law, it is forbidden to build nuclear power plants, nuclear fuel production plants and plants for reprocessing of spent nuclear fuel for nuclear power plants. It is also forbiden to making investment decisions, investment programs and technical documentation for the construction of nuclear power plants, production plants for nuclear fuel and plants for reprocessing spent nuclear fuel for nuclear power plants.

In May 2009 the Parliament of the Republic of Serbia adopted the Law 2009. In Article 1 stated that Law 2009 stipulates measures for protection of human life, health and environment from harmful effects of ionising radiation and nuclear safety measures regarding nuclear activities and regulates the conditions for practices with sources of ionising radiation and nuclear materials, as well as radioactive waste management.

In Article 2 of the Law 2009 stated that imports in the territory of the Republic of Serbia of radioactive waste and spent nuclear fuel of foreign origin are forbidden.

In Article 4 of the Law 2009 stated that the Government, at the proposal of the SRPNA, in order to provide the conditions for implementing the policy in the area of radiation and nuclear safety and

security and the policy of radioactive waste management, shall pass the Radiation Safety and Security Programme, Nuclear Safety and Security Programme and Radioactive Waste Management Programme, in line with the Law on the strategic assessment of environmental impact (Official Gazette RS 135/04 and 88/10).

E.2.2 National safety requirements and regulations

According to Article 7 of the Law 2009, the fundamental principles of the Law are justification of application, optimisation of radiation protection (ALARA) and individual exposure limitation. The prime responsibility for safety is set out in Article 4 of the Rulebook COLPNA, where is stated that the licensee for performing a nuclear activity has the primary responsibility for the safety of its nuclear facility. The Law 2009, inter alia, also includes, with respect to radiation protection areas, provisions on:

- radiation protection measures and systematic environmental radioactivity monitoring,
- authorisation for performing radiation protection activities,
- licensing for performing a radiation practice,
- conditions for locating, designing, construction, trial run, commissioning, use, permanent shut-down and decommissioning of nuclear facilities,
- procedure in case of an accident,
- radioactive waste management,
- import, export and transit of sources of ionising radiation, radioactive and nuclear materials,
- rights, obligations and authorisations of the inspector for nuclear safety and radioactive waste management and
- penalty provisions.

Within the legislative and regulatory framework which covers spent fuel and radioactive waste management, the regulation and rulebooks stated below should be mentioned:

- Regulation on determining the programme of nuclear safety and security
- Rulebook on conditions for obtaining licence to perform nuclear activity
- Rulebook on performance of nuclear activities
- Rulebook on radioactive waste management

E.2.3 Licensing system

A system of licensing of spent fuel and radioactive waste management is provided in the Law 2009 and in the Rulebook COLPNA.

Article 3 of the Law 2009 stated that nuclear facility is a facility where nuclear materials exist or are used, including the facilities for storage, treatment and disposal of radioactive waste. In Article 49 of the Law 2009 there is a general point which provides that a nuclear facility may be located, designed, built, put into the trial run, commissioned, used, permanently shut-down and its decommissioning launched only with a previously obtained licence for performing a nuclear activity. Since the facilities for storage, treatment and disposal of radioactive waste are defined by the Law 2009 as nuclear facilities, the entire spectrum of licensing requirements (for locating, designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning) have to be taken into consideration by the applicant.

According to Article 46 of the Law 2009, the following nuclear safety and security measures have to be undertaken for all activities regarding nuclear facilities, nuclear materials, radioactive waste, as well as in case of an accident:

- provision of the conditions for locating, designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning of nuclear facilities;
- fulfilment of the criteria for nuclear facility safety evaluation;
- provision of the conditions for trade and use of nuclear materials;
- provision and implementation of radiation protection measures in a nuclear facility and its vicinity;
- stipulating the required conditions to be met by the people working in a nuclear facility;
- provision of the conditions for collecting, recording, treating, storing and disposing of radioactive waste;
- physical protection of a nuclear facility;
- prevention of illicit trafficking of nuclear materials;
- provision of the conditions for implementing the Action Plan in case of an accident

Article 49 of the Law 2009 also stated that the licensee for performing a nuclear activity undertakes to obtain the licence from the SRPNA for any change or modification during locating, designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning of a nuclear facility.

The application for the licence and the required documentation shall be submitted by the legal person to the regulatory body. With the application for the licence, the applicant shall also deliver the opinion of the authority responsible for the environmental protection regarding the environmental impact assessment for the nuclear facility.

The license may be issued after it has been established that all required nuclear safety measures have been met, based on the nuclear safety report and other prescribed documentation which for each and every nuclear activity shall be stipulated by the regulatory body. The license shall be issued under a decision within 90 days following the license application, with validity of three years. The decision under which a licence is issued shall be published in the "Official Gazette of the Republic of Serbia".

The legal person undertakes to report to the regulatory body any change in data on the fulfilment of conditions that served as the basis for issuing the license for performing a nuclear activity.

The legal person undertakes, not later than 60 days before the expiration of the license for performing a nuclear activity, file for extension to the regulatory body. The extension of the license for performing a nuclear activity shall be done for the same time period and under the same conditions that served as the basis for issuing the previous licence.

Against the SRPNA decision on issuing or extension of the licence, an appeal may be field to the Minister responsible for nuclear safety and radioactive waste management. The decision of the Minister shall be final.

According to Article 50 of the Law 2009, Nuclear Safety Analisys Report shall contain:

- the assessment of potential environmental impact of the nuclear facility and potential environmental impact on that facility;
- the description of the nuclear facility under construction or the description of the present state of the nuclear facility;
- the data on the quality of installed equipment and construction materials, as well as other technical documents about the nuclear facility relating to its current state;
- the assessment of potential accidents and measures necessary for their prevention, as well as the measures to mitigate the consequences in case of an accident;
- the radioactive waste management plan;
- the description of physical protection system for the nuclear facility and other security measures;
- other required documentation.

In the same article also stated that the nuclear safety analysis report shall be supplemented in line with the changes occurring in the project during construction, trial run, commissioning, operation and permanent shut-down of a nuclear facility so that the report always addresses the current state of the nuclear facility.

The nuclear safety report for nuclear facility decommissioning shall be continually review and supplemented in line with the changes at the location and nuclear facility, changes in the technology or required procedures arising in the decommissioning process.

Regarding application of standards and technical regulations, in Article 51 of the Law 2009 is prescribed that nuclear facility has to be designed, built, put into trial run, commissioned, operate, maintained and permanently shut-downed according to the prescribed standards, technical regulations and product and service quality codes ensuring the prescribed nuclear safety and security of the facility. Also, the materials and equipment for construction and maintenance of the nuclear facility shall correspond in terms of quality to prescribed standards, technical regulations and quality codes, and service quality during construction and maintenance of such facilities shall correspond to the prescribed norms.

Article 56 of the Law 2009 stated that licensee for performing a nuclear activity, in the prescribed manner and according to the prescribed conditions, shall perform systematic environmental radioactivity monitoring in the vicinity of the nuclear facility which shall be funded by the owner of the nuclear facility.

According to Article 58 of the Law 2009 the licensee who produce, process, use or storage of nuclear materials is obliged to keep records of these materials in accordance with the ratified international treaties and to deliver data to the regulatory body.

Article 60 of the Law 2009 prescribed that licensee for performing a nuclear activity shall put in place and implement an integrated quality management system and undertakes methodically and systematically to apply the measures of the integrated quality management system to ensure that all technical, construction, organizational and human factors are under control, from the identification of safety requirements to the assessment of the fulfilment of such requirements.

The Law 2009 contains two articles directly related with radioactive waste management. In Article 63 of the Law 2009 stated that the licensee for performing a radiation practice or licensee for performing a nuclear activity is obliged to collect, keep, record and store radioactive waste in the prescribed manner and conditions. The licensee obligations are to:

- ensure that the buildings and premises where radioactive waste is collected, kept, recorded and stored meet the technical, safety and other required conditions ensuring the protection of people and the environment from ionising radiation;
- implement the measures preventing radioactive waste to cause the environmental contamination;
- secure the stored radioactive or nuclear material.

Article 64 stated that the Republic of Serbia takes care of temporary storage and permanent disposal of radioactive waste. There is also stated that radioactive waste, until the conditions are met for its permanent disposal, shall be temporarily stored with a legal person who poses the license for radioactive waste storage facility management. The licensee for radioactive waste storage facility management undertakes to keep records on radioactive waste and deliver data to the regulatory body within the periods as stipulated by the regulatory body. The licensee also shall take part in the costs of permanent disposal of radioactive waste. The amount of costs shall be stipulated by the Government.

Under the Article 48a of the Law 2009, nuclear facility management, which covers radioactive waste management, in the Republic of Serbia is an activity of public interest, performed only by PC NFS. Also, according to Article 7, paragraph 3, point 5) of the Statute of PC NFS, that company, inter alia, is responsible for radioactive waste management.

Detailed requirements regarding obtaining licence to perform nuclear activities are set out in the Rulebook COLPNA. As stated above, the licensee for performing a nuclear activity, including radioactive waste management, has the primary responsibility for the safety of its nuclear facility.

Under Article 5 of the Rulebook COLPNA the licensee may only be a legal person registered for performing nuclear activities which shall have employees who meet the conditions for working with nuclear materials. The conditions to be met by the licensee for performing a nuclear activity are organizational, technical-technological and quality assurance conditions. Under Article 7 of the Rulebook COLPNA, licensee shall:

- take measures for conducting a comprehensive and systematic safety analysis prior to construction and operating the nuclear facility, as well as for the entire period of its operation. This analysis shall be documented, regularly updated in terms of operational experiences and lessons learned in the area of safety and approved by the SRPNA;
- take measures for conducting verification by means of analyses, trial runs and inspections in order to ensure that the physical condition of the nuclear facility as well as performing the operations in it is in line with the design, safety requirements and operational conditions and restrictions;
- set up and implement an integrated quality management system in accordance with Article 60 of the Law 2009. The control of the integrated quality system measures implementation shall be conducted pursuant to the Rulebook PNA.

The licensee shall undertake all measures to put in place and apply adequate procedures for:

- valuation of all relevant location factors that may affect the nuclear facility safety during its operational life;
- valuation of potential effects of nuclear facilities on the safety of individuals, population and the environment;
- review of all relevant above mentioned factors when necessary in order to ensure continued acceptability of the nuclear facility from the safety aspect.

According to Article 9 of the Rulebook COLPNA, in the licensing application for performing nuclear activities, the legal person shall state and attach:

- the name of the nuclear activity for which it files the application (export-import; nuclear material use and transport; exploitation of ores containing a nuclear material; locating, designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning of nuclear facilities and the remediation of their locations; radioactive waste management);
- certificates of special education, basic and additional qualification in the area of ionizing radiation protection and nuclear safety, and additional training in performing the professional activities for the employees who will perform the nuclear activity;
- nuclear safety report for the nuclear activity;
- opinion of the authority competent for the environmental protection on the environmental impact assessment for the nuclear facility;
- evidence on the manner of providing funding for permanent shut-down and decommissioning of the nuclear facility in case of seeking the licence for locating, designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning of the nuclear facility (proof of establishing a special-purpose financial fund with payment schedule, an approved project design or signed contract with local or international institutions);
- other documentation provided for under the Rulebook PNA.

Apart from the evidence stated above, the application should also contain:

- the name of the legal person;
- the headquarters, phone number, fax and e-mail of the legal person;

- the registration number and tax identification number of the legal person;
- the decision on entry into the business register with the Business Registers Agency, or the decision of a competent court on entry into the court register;
- the information on organizational structure;
- the information on the person responsible for nuclear safety;
- the list of the employees meeting the conditions for working with nuclear materials that should also include the information on professional qualification, education, work experience and information on professional education;
- the approved version of Quality Manual for the integrated quality management system and the list of all documents of importance to the quality system including the employee professional training programme;
- the information on the previously issued relevant licence (if any).

The applicant for siting, designing, construction, trial run, commissioning, operation, permanent shut-down of nuclear facilities shall ensure that relevant financial funds are available when necessary in order to cover the costs of safe decommissioning including waste management as well.

The amount of financial funds to be made available for decommissioning activities correspond to the estimated value and shall be changed in case of increasing or decreasing the estimated value. The estimated value of decommissioning should be updated in line with a periodical overview of the decommissioning plan.

For the existing facilities without provided financial funding for decommissioning, the provisions regarding decommissioning funding are to be met prior to renewing or extending the licence.

Under Article 11 of the Rulebook COLPNA, if the licensee for performing a nuclear activity intends to terminate the performance of the activity for which they have been issued the license, they need to file an application for termination the activity.

The regulatory body shall set the deadline and conditions for implementing adequate remediation measures at the location and facility, the facility surroundings, as well as the conditions under which the licensee will be released from the obligations regarding nuclear facility management.

The conditions under which the licence may cease to be valid are:

- all responsibilities of the licensee based on the issued authorizations are met in a satisfactory manner and there are no reasonable expectations that the licensee will be responsible for anything remaining at the location;
- the required institutional control has been established including the environmental monitoring;
- the final radiological status of the nuclear facility has been fully documented;
- the radiological history of the employees and sub-contractors has been fully documented;
- the documentation is available to the public (except confidential information).

Under Article 12 of the Rulebook COLPNA, the licensee is obliged to report to the regulatory body any change in the data about the fulfilment of conditions pursuant to which they have been granted the license for performing nuclear activity not later than 30 days following the change.

The regulatory body shall within 30 days following the reception of the notice or decision from a nuclear safety inspector decide on revoking the licensee for performing a nuclear activity.

The license shall be revoked if:

- the license has expired, without seeking its extension;
- the licensee has terminated the activity for which the license has been issued;
- there has been a deviation from the licensing conditions.

The license includes:

- a unique identification number;
- a list of laws and rules as the basis for issuing the license, the official name of the regulatory body and the name of the government authorities to which the licensee is responsible for meeting the license conditions;
- information on the legal person responsible for the licensed facility or activity;
- a sufficiently detailed presentation of the nuclear facility, location and activity, including the clear layout (drawing) and description of location's borders and other layouts as necessary;
- the obligation to report to the regulatory body any changes of importance to safety;
- licensee's obligation in terms of the facility safety and in terms of the safety of equipment, radioactive sources, employees, population and the environment;
- conditions and restrictions (dose limits, discharge limits, intervention levels, licence term);
- special additional authorizations which the licensee should be granted by the regulatory body;
- the reporting obligation towards the regulatory body concerning emergencies;
- the regular reporting obligation towards the regulatory body;
- the obligation to retain the records including the time frame of such retention;
- the manner and procedure for changing any information contained in the licence;
- the list of documentation: the documentation prepared for filing the licensing application by the applicant as well as the documentation used by the regulatory body in the overview and assessment process;
- the connection to other licences;
- the procedure for revoking a licence or part of licence;
- licensing conditions regarding the safety of a nuclear facility or a nuclear activity.

The Rulebook COLPNA also contains provisions regarding person responsible for nuclear safety, siting a nuclear facility, nuclear facility design and construction, conditions for trial run of a nuclear facility, conditions for commissioning and operation of a nuclear facility and permanent shut-down of a nuclear facility.

On the basis of Article 63 and 64 of the Law 2009, the SRPNA adopted Rulebook RWM which contains detailed provisions regarding manner of temporary storage of radioactive waste, manner and conditions of keeping, collecting, storage, treatment and disposal of radioactive waste and records of radioactive waste.

E.2.4 System of prohibition of the operation of a spent fuel or radioactive waste management facility without a license

The radioactive waste management facilities are defined by the Law 2009 as nuclear facilities. Consequently, all relevant licenses are needed, including the operating license. The operation of such a facility without a license is prohibited according to Article 49 of the same law, where stated that a nuclear facility may be located, designed, built, put into the trial run, commissioned, operated, permanently shut-down and its decommissioning launched only with a previously obtained licence for performing a nuclear activity which is issued by the SRPNA.

In the same article also stated that the licensee for performing a nuclear activity is obliged to obtain the licence from the SRPNA for any change or modification during locating, designing,construction, trial run, commissioning, operation, permanent shut-down and decommissioning of a nuclear facility.

In Article 84 of the Law 2009 it is foreseen that the fine amounting from RSD 1,500,000 to 3,000,000 shall be imposed for an economic offence on a legal person if such legal person locates, designs, constructs, starts a trial run, commissions, operates, permanently shuts-down nuclear facility or decommissions the nuclear facility without a prior licence obtained from the SRPNA. For the same

economic offence, the responsible person of the legal person shall be also fined the amount from RSD 100,000 to 200,000.

E.2.5 System of appropriate institutional control, regulatory inspection and documentation and reporting

Under Article 76 of the Law 2009, inspection control over implementing nuclear safety measures shall be performed by the Ministry responsible for nuclear safety and radioactive waste management through the inspector for nuclear safety and radioactive waste management.

In Article 80 of the Law 2009 stated that in performing the inspection control over implementing nuclear safety measures, the inspector for nuclear safety and radioactive waste management has the right and obligation to establish:

- whether the conditions have been met for performing a nuclear activity;
- whether the required nuclear safety and security measures have been implemented;
- whether other measures provided for under Law have been implemented.

Regarding authorisations of the inspector for nuclear safety and radioactive waste management in Article 81 of the Law 2009 is prescribed that the inspector for nuclear safety and radioactive waste management is authorised to:

- forbid the designing, construction, trial run, commissioning, operation, permanent shut-down and decommissioning of a nuclear facility if the required nuclear safety and security measures have not been met;
- forbid the trade of nuclear materials if the required conditions have not been met;
- forbid the work of persons in a nuclear facility if they have not met the required conditions;
- order that the required conditions should be met and other faults removed for which is established that they may cause harmful consequences to the human health, work or living environment;
- order that faults should be removed regarding radioactive waste management;
- order that faults should be removed regarding the measures for physical protection and technical protection and security of nuclear facilities;
- control the implementation and application of required measures in case of an accident;
- order other measures in case of the failure to meet nuclear safety and security measures.

It should be stated that in the Republic of Serbia is in force the general Law on inspection oversight (Offcial Gazette RS 36/15) which governs the scope, forms, and procedure of inspection oversight, powers and duties of parties to inspection oversight, and other issues of relevance for inspection oversight and which is to be followed also by radiation and nuclear safety inspectors.

E.2.6 The enforcement of applicable regulations and of the terms of the licenses

The enforcement of applicable regulations and of the terms of the licenses is ensured by the application of penal provisions related to the issuing, extending and revoking licences for performing nuclear activity, as provided for in the Law 2009 and in the Law on inspection oversight.

E.2.7 Allocation of responsibilities

As described above, the legislative framework, especially the Law 2009 and mentioned bylaws provides a clear allocation of responsibilities of the bodies involved in the different steps of radioactive waste management (licence holder, mandatory state-owned public services, regulatory body) as well as a system of documentation and reporting.

A comprehensive overview of the legislative and regulatory framework which governs nuclear, radiation, transport and radioactive waste safety is attached to this report in Annex L.2. The list consists of the national legal framework as well as the international instruments (multilateral and bilateral treaties, conventions, agreements/arrangements) to which the Republic of Serbia is a party.

E.3 Regulatory body

Article 20: Regulatory body

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.
2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.

E.3.1 Regulatory body – Serbian Radiation Protection and Nuclear Safety Agency

SRPNA was established by the Decision on establishment of the Serbian Radiation Protection and Nuclear Safety Agency („ Official Gazette“, no. 76/09 and 113/13), adopted by the Serbian Government, according to Law 2009 and Law on public agencies, with the purpose of ensuring the conditions for quality and efficient undertaking of radiation protection measures and nuclear safety measures during radiation practices and nuclear activities. According to Article 5 of the Law 2009, SRPNA was established as independent regulatory organization performing public authorizations in accordance with the Law 2009. SRPNA is organized within the Ministry of Environmental Protection, which provided the financial resources for SRPNAs operating from the state budget. The budget is the only source for financing the SRPNA activities. Also for nuclear safety matters, SRPNA is under control of the Ministry of Education, Science and Technological Development. SRPNA has the Management Board which consists of 5 members, appointed by the Government.

Under Article 6 of the Law 2009, SRPNA is responsible for:

1) passing the bylaws for implementing this Law;
2) passing the Programme of Systematic Environmental Radioactivity Monitoring;
3) passing the Programme for Additional Training and Qualification of Occupationally Exposed Persons and Persons Responsible for Radiation Protection;
4) passing the Programme of Early Warning of Emergency
5) preparing the draft Programmes of the Radiation Safety and Security Programme, Nuclear Safety and Security Programme and Radioactive Waste Management Programme;
6) preparing the draft Action Plan in the Case of an Accident;
7) producing instructions and procedures required for implementing radiation and nuclear safety and security measures;
8) issuing, extending and revoking licences for performing a radiation practice or nuclear activity;
9) issuing and revoking permits for trade of radioactive and nuclear materials;
10) issuing, extending and revoking decisions for legal entities or entrepreneurs on performing radiation protection activities, a radiation practice or nuclear activity;
11) issuing confirmation of notification for sources of ionising radiation;
12) issuing certificates to persons responsible for radiation protection;

13) setting the amount of fees for issuing licenses, permits, decisions, confirmation of registration and other certificates; keeping the registry of applications and issued licenses, permits, decisions, confirmation of notification and other certificates;
14) keeping the registry of applications and issued licenses, permits, decisions, confirmation of notification and other certificates;
15) setting up and maintaining a database (centralised registry) on sources of ionising radiation and their users, occupationally exposed persons, and other data relevant for radiation protection, radiation and nuclear safety and security;
16) keeping the centralised records on nuclear facilities, nuclear materials and radioactive waste and running control over the records kept by users;
17) monitoring the radioactivity levels and their changes and assessing their impact on the population and the environment and in that relation ordering the implementation of required measures and monitoring their execution;
18) publishing the annual report on the exposure levels of the population to ionising radiation in the Republic of Serbia;
19) running the control of the fulfilment of conditions serving as the basis for issued licences, permits and decisions under items 8), 9) and 10);
20) ensure the transparency in working on the enforcement of this Law and in the procedure for passing bylaws;
21) delivering to the media, responsible government authorities and the International Atomic Energy Agency the information of relevance for radiation and nuclear safety and security;
22) conducting the cooperation with responsible government authorities in its scope of activities;
23) conducting independently or in coordination with the responsible government authorities the cooperation with the International Atomic Energy Agency and other international bodies and the responsible authorities of other countries regarding the enforcement of this Law;
24) giving opinion at the request of the responsible government authorities regarding the joining to the international conventions and other agreements in the field of radiation and nuclear safety and security;
25) performing other operations provided for under the law.

The tasks under Items 1), 2), 3), 4), 8), 9), 10), 11), 12), 14), 15), 16), 17) and 21) are performed by the SRPNA as entrusted tasks.

E.3.1.1 Organisation

The SRPNA is organised into three departments. These are:

- Radiation Safety and Security Department
- Nuclear Safety and Security Department
- Supervision and control of licence and authorization holders, legal and financial, general administrative and procurement affairs Department

Organizational chart of the SRPNA is given in Figure 41.

SRPNA had 24 employees at the end of the year 2017.

The staff of SRPNA is interdisciplinary, consisting of employees with different educational backgrounds: physicists and physical-chemists, electrical/nuclear engineers, lawyers, economists and administrative workers.

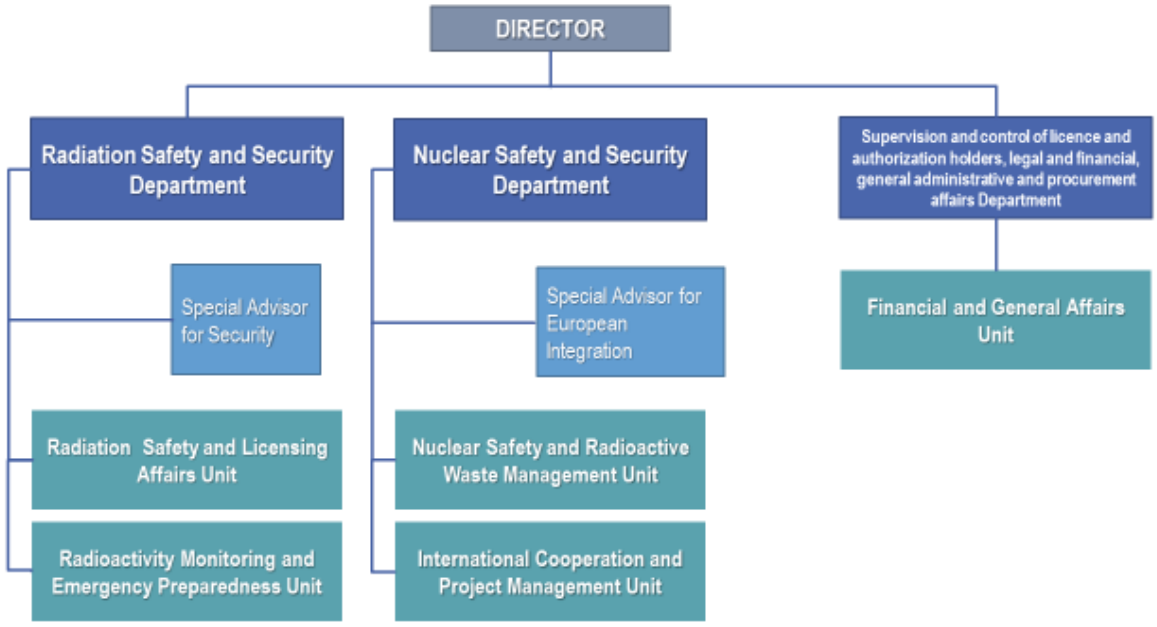

Figure 41. Organizational chart of the SRPNA

The structure of the employees at the end of the year 2017 was as follows: the director, who is appointed by the Government, 3 assistant directors, 2 special advisers, 5 unit heads, 10 specialists, 1 associate, 2 employees engaged by service contract and 1 member of technical staff.

Regulatory matters related to radioactive waste management are dealt with by the Nuclear Safety and Security Department.

E.3.2 Effective independence

As stated below, according to Article 5 of the Law 2009, SRPNA was established as a regulatory organization performing public authorizations in accordance with the Law 2009. SRPNA is organised within the Ministry of Environmental Protection. The founding and legal position of the SRPNA shall be subject to the provisions of the Law governing public agencies. The consent to the official document defining the amount of salaries and the number of employees in the SRPNA shall be given by the Government.

Under Article 77 of the Law 2009 the control over the SRPNA's work in performing the entrusted tasks shall be performed, within its scope, by the Ministry responsible for radiation protection and the Ministry responsible for nuclear safety and radioactive waste management, in accordance with the regulations governing the government administration.

Inspection control over implementing radiation protection measures shall be performed by the Ministry responsible for radiation protection through the inspector for radiation protection.

Inspection control over implementing nuclear safety measures shall be performed by the Ministry responsible for nuclear safety and radioactive waste management through the inspector for nuclear safety and radioactive waste management.

Against SRPNA's decision on issuing or extension of the licence for performing a radiation practice, an appeal may be filed to the Minister responsible for radiation protection. Against the SRPNAs decision on issuing or extension of the licence for performing a nuclear activity, an appeal may be field to the Minister responsible for nuclear safety and radioactive waste management. The decision of the Ministers shall be final.

Section F. Other General Safety Provisions

F.1 Responsibility of the licence holder

Article 21. Responsibility of the licence holder

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.
2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

Responsibility of the licence holder for safe management of radioactive waste is set out in Article 63 of the Law 2009. Under this Article, licensee is responsible to ensure that the buildings and premises where radioactive waste is collected, kept, recorded and stored meet the technical, safety and other required conditions ensuring the protection of people and the environment from ionising radiation, to implement the measures preventing radioactive waste to cause the environmental contamination and to secure the stored radioactive or nuclear material.

Article 35 of the Law 2009 forsee that the licensee for performing a radiation practice or the licensee for performing a nuclear activity undertakes to store the radioactive waste generated as a result of operations in its own premises, depending on the type of radiation practice or nuclear activity. Radioactive waste can be kept in such manner not more than one year. After expiry of that time period licensee is obliged to hand it over to the licensee for radioactive waste storage facility management.

Article 49 of the Law 2009 prescribed that the license for the radioactive waste management may be issued after it has been established that all required nuclear safety measures have been met, based on the nuclear safety report and other required documentation.

Rulebook COLPNA, Article 4, prescribes that the licensee for performing a nuclear activity has the primary responsibility for the safety of its nuclear facility.

Rulebook COLPNA, Article 10, prescribes that the licensee is responsible for the safety of the nuclear facility or nuclear activity until the facility or activity is released from regulatory control by the SRPNA.

Rulebook PNA, Article 6, prescribed that the licensee shall ensure that the license to operate the nuclear facility is based on appropriate safety analyses and operating programmes which prove that the facility's construction is compliant with the design and safety requirements.

F.2 Human and financial resources

Article 22. Human and financial resources

Each Contracting Party shall take the appropriate steps to ensure that:

(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;
(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;

(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.2.1 Availability of qualified staff

Rulebook PNA, Article 3, stated that the licence holder shall provide a sufficient number of qualified staff with the corresponding level of education, training and additional training for all activities related to the safety of the nuclear facility and nuclear activities.

Rulebook PNA prescribes plan and programme of professional training of employees, methods and frequency of traing and examination.

Rulebook COLPNA, Article 10, prescribes that the applicant or licensee should prove in their licensing application that they have in place and that they will continue to provide adequate human resources for safe construction, maintenance, operation and decommissioning of the nuclear facility, as well as that the regulatory requirements and nuclear safety requirements are met and will continue being met throughout the whole lifetime of the facility.

PC NFS as the only licensee for radioactive waste management has around 120 employees at date of reporting of which around 30 is directly involved in activies related to storage of radioactive waste. The rest of the employees are staff employed in two research reactors, radiation protection, establishment of Waste Processuig Facility, security, firefighters, medicine and administration.

F.2.2 Availability of adequate financial resources

Accoirding to the Article 64 of the Law 2009, Republic of Serbia takes care of temporary storage and permanent disposal of radioactive waste. Radioactive waste, until the conditions are met for its permanent disposal, shall be temporarily stored within a legal person with the license for radioactive waste storage facility management. The licensee shall take part in the costs of permanent disposal of radioactive waste. The amount of costs shall be stipulated by the Government.

Rulebook PNA, Article 3, stated that the licence holder shall provide adequate financial assets to assure the conditions for nuclear safety when performing nuclear activities.

Rulebook COLPNA, Article 10, prescribes that the applicant or licensee should prove in their licensing application that they have in place and that they will continue to provide adequate financial funding.

The only licencee for radioactive waste management in the Republic of Serbia is state owned PC NFS. This company is financed from the state budget.

F.2.3 Financial provision and monitoring arrangements following the closure of a disposal facility

Rulebook COLPNA, Article 31, prescribes that the nuclear facility operator undertakes, before the permanent shut down of the nuclear facility, to produce a permanent shut down programme and a project proposing the phases and timelines for performing such works, taking into account radiation protection and radiation safety.

If the operator of a near-surface disposal for radioactive waste materials intends to close down the disposal permanently, they previously have to produce a disposal closedown programme which contains the measures for:

1) accommodating the radioactive waste from interim storage facilities in the disposal and into the disposal units;
2) decontamination of the radioactive waste treatment facility;

3) dismantling the equipment, tearing down the buildings or their remediation otherwise;
4) producing a programme for maintaining and monitoring the disposal units and disposal drainage system for the period of five years following the closedown of the disposal;
5) radiation protection for professionally exposed people at the disposal and the environmental protection.

The operator of a near-surface disposal for radioactive waste materials undertakes to deliver to the SRPNA the project of performed works, the records of disposed radioactive waste and geodetic survey of the location.

The operator of a near-surface disposal for radioactive waste materials undertakes to ensure its active maintenance for the period of five years following the overlaying of the disposal units.

Article 11 of the same Rulebook prescribes that the conditions under which the licence may cease to be valid are:

1) all responsibilities of the licensee based on the issued authorizations are met in a satisfactory manner and there are no reasonable expectations that the licensee will be responsible for anything remaining at the location;
2) the required institutional control has been established including the environmental monitoring;
3) the final radiological status of the nuclear facility has been fully documented;
4) the radiological history of the employees and sub-contractors has been fully documented;
5) the documentation is available to the public (except confidential information).

There is no statement relating to financial resources following the closure of a disposal facility.

There is no disposal facility in Republic of Serbia at the time of reporting.

F.3 Quality assurance

Article 23. Quality assurance

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

Article 60 of the Law 2009 prescribes that the licensee for performing a nuclear activity shall put in place and implement an integrated quality management system. The licensee undertakes methodically and systematically to apply the measures of the integrated quality management system to ensure that all technical, construction, organizational and human factors are under control, from the identification of safety requirements to the assessment of the fulfilment of such requirements.

Rulebook PNA prescribes the methodology for the development of quality assurance programmes for nuclear facilities.

PC NFS as the only lecence holder for the radioactive waste management in the Republic of Serbia is accredited according to ISO9001:2015.

F.4 Operational radiation protection

Article 24. Operational radiation protection

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:
   (i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;
   (ii) no individual shall be exposed, in normal situations, to radiation doses which exceednational prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and
   (iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.
2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:
   (i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and
   (ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.
3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.4.1 ALARA principle and dose limitation

Fundamental principles of radiation protection in radiation practices, nuclear activities and radioactive waste management is given in the Law 2009, Article 7. Those principles are:

1) justification of application – conditions and permissibility to perform the present and future radiation practices, nuclear activities and radioactive waste management activities shall be determined and assessed according to the economic, social and other benefit which their performance provides to the society as opposed to the radiation risks that may occur due to their performance, taking into account the best available data on their efficiency or consequences;
2) optimization of radiation protection – every activity must be performed so as to have exposure to ionizing radiation as low as it is objectively achievable given the economic and social factors;
3) individual exposure limitation – radiation practice must be planned so as to have individual exposures always below prescribed limits.

Article 42 of the Law 2009 forsees that ionising radiation exposure is forbidden above the limits stipulated for population to persons under 18 years of age, except those older than 16 in the course of the training for work with sources of ionising radiation. The same article forsees that occupationally exposed persons, persons under the trainning and population shall not be exposed to ionising radiation above the prescribed limits.

Exposure limits for professionally exposed persons, persons on training and population are prescribed by the Rulebook on Limits of Exposure to Ionizing Radiation and Measurements for Assessment of the Exposure Levels. Effective dose limits for professionally exposed persons is 100 mSv for five consecutive years (average value 20 mSv per year), with the additional restriction that in any year it does not exceed a value of 50 mSv. Effective dose limits for persons between 16 and 18 years old, which use sources during education is 6 mSv per year. Effective dose limits for individuals from the population is 1 mSv per year. Persons under 16 years are prohibited from professional exposure. Persons under the

age of 18 are prohibited from working in the controlled area, except during training and regular education and under mandatory supervision.

F.4.2 Limitation of discharges

Rulebook on radioactivity monitoring, Article 13 prescribes that the control of the level of radioactive contamination of the environment in the surroundings of the nuclear facility is performed by controlling the emission of radioactive effluents from the nuclear facility and the radionuclide contents in the environment in regular conditions and in case of an emergency.

Rulebook on Limits of Radioactive Contamination of People, Working and Living Environment and Ways of Performing Decontamination prescribes that the material may not be disposed of in the living environment, without further supervision of the SRPNA, if the content of radionuclides with artificial origin in that material is higher than the prescribed limits for clearance from regulatory control. Exceptionally, the SRPNA may approve disposal in the living environment if that material makes no hazard to the population and the living environment. Dilution of the material, in order to achieve activity that is below the clearance level, is not allowed. The limits of radioactive contamination of fluid and gaseous radioactive effluents which may be released into the living environment shall be separately defined for each location and facility where radioactive effluents appear, on the basis of the impact to the living environment and the annual limit of public exposure.

F.4.3 Implementation of corrective measures to control the release and mitigate its effects

Law 2009, Article 63 forsees that the licensee for performing a radiation practice or licensee for performing a nuclear activity have to implement the measures preventing radioactive waste to cause the environmental contamination.

Implementation of corrective measures are forseen in safety analysis reports for all radioactive waste management activities performed in PCNFS.

F.5 Emergency preparedness

Article 25. Emergency preparedness

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.
2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

Law, Article 62 forsees, in order to protect the human lives and health and the environment in case of an accident, that the Government of Republic of Serbia shall adopt the Action Plan in Case of an Accident. The Plan shall stipulate intervention and derived intervention levels of ionising radiation exposure and protection measures for population and the environment from harmful effects of ionising radiation, the manner of public notification, as well as an operational programme for implementing the whole Plan or its parts. The accident threatening the territory of the Republic of Serbia shall be declared by the Government, as proposed by the SRPNA. The protection of human lives and health and the environment from ionising radiation in an accident shall be implemented according to the required measures for prevention and removal of the consequences caused by such event. If it is established that

there is a contamination spreading hazard from the territory of the Republic of Serbia to the neighbouring countries, the Government of the Republic of Serbia shall inform of such hazard the IAEA and the responsible authorities of the neighbouring countries. The Action plan in case of an accident and activities undertaken shall be implemented in line with the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency.

Action Plan in Case of an Accident for the Republic of Serbia is in process of adoption at the time of preparing this Report.

Rulebook PNA forsees that the licence holder shall prepare Action Plan for the case of an emergency in the nuclear facility and during the performance of nuclear activities, which is the subject to periodical reviews and shall encompass all activities that must be executed in case of an emergency. For new nuclear facilities, the plan must be prepared and tested before the beginning of operation and approved by the SRPNA.

Rulebook PNA forsees that response procedures must be established for events for which it is assumed that they could occur during regular operation as well as in emergencies. Any emergency that is important for the safety must be reported to the SRPNA within the legally stipulated period of time.

Rulebook COLPNA, Article 23 prescribes that the nuclear facility operator shall submit to the SRPNA the action plan for emergency situations.

PCNFS as the only operator of radioactive waste management facilities in Serbia developed the Plan in case of an emergency for each facility.

F.6 Decommissioning

Article 26. Decommissioning

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(i) qualified staff and adequate financial resources are available;
(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;
(iii) the provisions of Article 25 with respect to emergency preparedness are applied; and
(iv) records of information important to decommissioning are kept.

Law, Article 54 forsees that in the case of permanent shut-down and decommissioning of the nuclear facility, the licensee for performing a nuclear activity undertakes, within the period as set by the SRPNA, to perform adequate remediation measures at the location and at the facility and in its vicinity.

Legal framework for decommissioning in Republic of Serbia need to be improved.

Section G. Safety of Spent Fuel Management

As already stated in this Report, Republic of Serbia has:

- no nuclear power reactors,
- no defence reactors for research or other purposes,
- no spent nuclear fuel in storage or awaiting treatment.

Spent nuclear fuel from the research reactor RA was repatriated to the Russian Federation in 2010.

As a consequence of the adoption of the Law banning construction of nuclear power plants in SFR Yugoslavia issued by the National Assembly of SFR Yugoslavia in 1989 and its consecutive adoption in the Parliaments of FR Yugoslavia in 1995 and of Republic of Serbia in 2005, there are, at present, no considerations or plans for taking any kind of nuclear reactors into operation and any kind of facilities for management of spent nuclear fuel for nuclear power plants in Republic of Serbia. Thus, there are no plans for siting, designing, constructing or operating spent fuel facilities.

All safety provisions relevant for radioactive waste management are applicable to spent nuclear fuel management as described in Section H.

G.1 General safety requirements

Article 4. General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards. In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

(iii) take into account interdependencies among the different steps in spent fuel management;

(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;

(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

(vii) aim to avoid imposing undue burdens on future generations.

All safety provisions relevant for radioactive waste management are applicable to spent nuclear fuel management as described in Section H.

G.2 Existing facilities

Article 5. Existing facilities

Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

There is no spent nuclear fuel management facilities on the territory of Republic of Serbia.

G.3 Siting of proposed facilities

Article 6. Siting of proposed facilities

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:
   (i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
   (ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
   (iii) to make information on the safety of such a facility available to members of the public;
   (iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

Sitting of spent nuclear fuel maangment facilities is forbidden on the territory of Republic of Serbia.

G.4 Design and construction of facilities

Article 7. Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;
(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;
(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

Design and construction of spent nuclear fuel management facilities is forbidden on the territory of Republic of Serbia.

G.5 Assessment of safety of facilities

Article 8. Assessment of safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

Construction of spent nuclear fuel management facilities is forbidden on the territory of Republic of Serbia. All safety provisions relevant for radioactive waste management are applicable to spent nuclear fuel management as described in Section H.

G.6 Operation of facilities

Article 9. Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

All safety provisions relevant for radioactive waste management are applicable to spent nuclear fuel management as described in Section H.

G.7 Disposal of spent fuel

Article 10. Disposal of spent fuel

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

All safety provisions relevant for radioactive waste management are applicable to spent nuclear fuel management as described in Section H.

Section H. Safety of Radioactive Waste Management

H.1 General safety requirements

Article 11. General safety requirements

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards. In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;
(ii) ensure that the generation of radioactive waste is kept to the minimum practiceable;
(iii) take into account interdependencies among the different steps in radioactive waste management;
(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;
(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;
(vii) aim to avoid imposing undue burdens on future generations.

H.1.1 Criticality and removal of residual heat

Rulebook RWM, Article 8, prescribes that the manners and conditions for radioactive waste management are determined based on their characteristics which is, among others, criticality and heat generation.

Small amount of fissile material are kept in Hangar H1 and Secure Storage (materials under the Safeguards control) and there is no possibility for criticality. There is no radioactive waste with heat generation in H0, H1, H2, H3 and Secure Storage. Safety assessment reports for these facilities, as obligatory part of licensing process, address the issue of criticality and heat removal.

H.1.2 Generation of radioactive waste is kept to the minimum practicable

Rulebook RWM Article 7, prescribes avoidance of generation, which means reduction in quantity of generated radioactive waste as a mandatory measure.

All license holders are obliged to prepare plans for the management of radioactive waste as the part of licensing process. Such plans for all facilities include measures to provide that generation of radioactive waste is minimized.

Rulebook PNA, Article 6, prescribes that the license holder shall ensure that the radioactive waste generated during the performance of nuclear activities is reduced to the minimum, both in respect of activity content, as well as in respect of the volume.

H.1.3 Interdependencies among the different steps in radioactive waste management

Rulebook PNA, Article 6, prescribes that the license holder shall ensure that procedures necessary for the treatment and storage of spent fuel and radioactive waste generated in nuclear activities must take into account the requirements for conditioning and disposal.

Issue of interdependencies is described in safety analysis report for each nuclear facility wich is obligatory part of the documentation in the licensing process.

H.1.4 Effective protection of individuals, society and the environment

General measures for effective protection of individuals, society and the environment in Republic of Serbia are laid down in the relevant legislation, particularly:

- Law on Radiation Protection and on Nuclear Safety
- Rulebook on Radioactive Waste Management
- Rulebook on Performance of Nuclear Activities
- Rulebook on Conditions for Obtaining Licence to Perform Nuclear Activity
- Rulebook on Limits of Exposure to Ionizing Radiation and Measurements for Assessment of the Exposure Levels
- Rulebook on Radioactivity Monitoring

The overall principles listed in Law 2009, Article 7 are:

- justification of application
- optimization of radiation protection
- individual exposure limitation

Particularly, Rulebook PNA, Article 7, prescribes that the licence holder shall take adequate measures to ensure that during all operations the exposure to ionizing radiation of employees and population is as low as it is objectively achievable, so that it does not come to exposure that will exceed the permitted limits. Limits are set out in Rulebook on Limits of Exposure to Ionizing Radiation and Measurements for Assessment of the Exposure Levels

Effective protection of individuals, society and the environment is described in safety analysis report for each nuclear facility wich is obligatory part of the documentation in the licensing process.

H.1.5 Taking into account the biological, chemical and other hazards

According to the Rulebook RWM, generator of the radioactive waste and licensee of radioactive waste management facility are obliged to take into account biological, chemical and other characteristics of radioactive waste and to take protective measures in order to prevent such hazards.

H.1.6 Avoid actions that impose reasonably predictable impacts on future generations

There is no such statement in the legislation. Issue of avoidance actions that impose reasonably predictable impacts on future generations is described in safety analysis report for each nuclear facility wich is obligatory part of the documentation in the licensing process.

H.1.7 Avoid imposing undue burdens on future generations

There is no such statement in the legislation. Issue of avoidance actions that avoid imposing undue burdens on future generations are described in safety analysis report for each nuclear facility wich is obligatory part of the documentation in the licensing process.

H.2 Existing facilities and past practices

Article 12. Existing facilities and past practices

Each Contracting Party shall in due course take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

H.2.1 Existing facilities

Existing facilities at the time the Joint Convention entered into force in the Republic of Serbia are hangars H0, H1, H2, H3 and Secure Storage, underground liquid waste tanks VR1-VR4 and Radium Bunker. Licensing conditions are set out in the Law 2009 and relevant rulebooks (Rulebook RWM, Rulebook COLPNA and Rulebook PNA).

Obligatory part of licensing process for all nuclear facilities is Safety Assessment Report. Detailed scope and content of this document is set out in Rulebook COLPNA. Licence for the nuclear activity is valid for the period of three years. After expiration of this period, licence holder is obliged to apply for the extension of the licence including updated Safety Analysis Report.

H.2.1.1 Hangars H1 and H2

Hangars H1 and H2 are licenced for final shut down in September 2016. Detailed safety assessment for the activities planned in those facilities are performed and described in Safety Analysis Report [5]. Activities planned in those facilities are retreival of all radioactive waste and their treatment in the waste processing facility and storage in Hangar H3 or Secure Storage. These activities will significantly improve safety on the Vinča site.

H.2.1.2 Hangar H3 including H0

Construction of Hangar H3 is finished in 2010. Licence for trial run was obtained in September 2011. Licence for commissioning of Hangar H3 was obtained in September 2012. After the Hangar H3 was put into operation, it was concluded that there is a need for storage space for radioactive waste that not fulfill waste acceptance criteria for H3. Based on analyses performed and upgrades of the facility, part of the Hangar H0 is licenced to accept radioactive waste in 2013 according to the addendum to the licence for H3. Review of Safety Analysis Report for Hangar H3 including H0 was done in 2015 due to the expiration of previous licence. Licence for the opearation of Hangar H3 including H0 was issued in February 2015. In the time of writing this Report, review of updated Safety Analysis Report [6] is ongoing.

H.2.1.3 Secure Storage

Construction of Secure Storage is finished in 2010. Licence for trial run was obtained in September 2011. Licence for commissioning of Secure Storage was obtained in September 2012. Review of Safety Analysis Report for Secure Storage was done in 2015 due to the expiration of previous licence. Licence for the opearation of Secure Storage was issued in March 2015. In the time of writing this Report, review of updated Safety Analysis Report [7] is ongoing.

H.2.1.4 Underground liquid waste tanks VR1-VR4

Liquid radioactive waste is stored in underground liquid waste tanks VR1 – VR4 which are not licensed. From the safety point of view the treatment of liquid radioactive waste stored in these tanks, dismantling of the old piping system and tanks proves to be quite important. Currently there are no posibilities for treatment of liquid waste in Serbia.

Activities regarding treatment of liquid radiaoctive waste were planned under IPA projects programmed in 2009 and 2010 and funded by the European Commission. Under this project all liquid radioactive waste stored in four underground waste tanks and in spent fuel storage pool was planned to be treated and stored in new storage facilities. Financing of this project was stopped in 2016 without any activities done. In 2017 European Commission agreed to fund project which covers sampling and analyzing radioactive liquid waste stored on Vinča site in spent nuclear fuel pool, adjacent piping and tanks VR1-VR4, soil testing in adjacent areas, and proposing of problem solving technology. These activities will lead to finding appropriate solution to solve this issue in order to improve the safety on the site.

H.2.1.5 Radium Bunker

Radium Bunker is used as temporary storage for several grams of radium 226. Until 1999 radiological control of the facility was regularly performed. Closed concrete sarcophagus with wall thickness of 90 cm was built around the bunker during the NATO bombing in 1999. The sarcophagus is covered with soil and there is no possibility for any kind of inspection. Facility is not licenced.

In 2017 European Commission agreed to fund project wich main objective is to retrieve, to process and to store the radium sources stored in this facility in order to improve safety on the locaton.

H.2.2 Past practices

Past practices that resulted in generation of radioactive waste in Republic of Serbia included mining and processing of uranium ore in Gabrovnica mine and assosicated hydromettalurgical plant as well as small scale past practices that were performed in several research institutes.

H.2.2.1 Abandoned uranium mine in Gabrovnica

The uranium mine and hydrometallurgical plant in Gabrovnica near Kalna was in operation from 1963 to 1965. This plant consisted of a mining tunnel, bathrooms, mills, filtration, boiler rooms, warehouses, workshops, pumping stations, transformers, administrative office and tailings. Main entrance to the mine tunnel was blocked with concrete wall.

The facilities at Gabrovnica site are in very bad condition, most of them ruined and useless. There is no any decision regarding future activities at this site. Remediation activities has to be performed in order to improve safety on the locaton.

H.2.2.1 Research laboratories and facilities

Research laboratories in Vinča Institute, Institute for Technology of Nuclear and other Mineral Raw Materials and several other smaller research institutions were the largest users of sources and materials in research activities. Research activities that took place in these laboratories include medical, biomedical, biological science, materials science, development of nuclear technologies etc. Most of these laboratories need to be surveyed for sources, materials and contamination left and subsequently decontaminated.

H.3 Siting of proposed facilities

Article 13. Siting of proposed facilities

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:
   (i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
   (ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
   (iii) to make information on the safety of such a facility available to members of the public;
   (iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

H.3.1 Evaluation of site related factors and likely safety impact

According to the Law 2009, Article 48, nuclear facility may be built only at the location for which a spatial and urban plans have been adopted. These plans have to be in accordance with regulations governing planning and construction of facilities and regulations governing the environmental impact assessment procedure. The Parliament, at the Government request, shall discuss the justification of building a nuclear facility and shall communicate its standpoint to the Government.

Obligatory part of licensing process for all nuclear facilities is safety assessment report. Detailed scope and content of this document is set out in Rulebook COLPNA. Assessment must include site related factors (climate, geology, hidrology, seismology, demographic etc.) and safety impact on people and environment.

H.3.2 Evaluation of safety impact on individuals, society and the environment

Analysis of impact of the facility on individuals, society and the environment is obligatory under the Law 2009 and Law on Environmental Impact Assessment (Official Gazette RS 135/2004, 36/2009).

H.3.3 Information on safety available to the members of the public

Public hearings are mandatory in the process for approval of environmental impact assessment report for nuclear facilities according to the Law on Environmental Impact Assessment (Official Gazette RS 135/2004, 36/2009).

H.3.4 Consultation with Contracting Parties

Republic of Serbia is a signatory of Aarhus Convention and will take due account of all relevant aspects of the requirements for consultation with Contracting Parties in accordance with that convention.

H.3.5 Proposed facilities

There is no proposed radioactive waste management facilities at the time the Joint Convention entered into force in the Republic of Serbia.

H.4 Design and construction of facilities

Article 14. Design and construction of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;
(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;
(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;
(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

H.4.1 Measures to limit possible radiological impacts

Rulebook COLPNA, Article 19, sets out that the systems in the nuclear facility shall be designed so as to ensure, among others, radiation protection and radiation safety in operational conditions and in the design basis events and occupational safety.

H.4.2 Provisions for the decommissioning of a radioactive waste management facility

Rulebook COLPNA, Article 19, sets out that the systems in the nuclear facility shall be designed so as to ensure, among others, procedure of permanent closedown of the nuclear facility and its decommissioning.

H.4.3 Technical provisions for the closure of a disposal facility

Rulebook COLPNA, Article 21, sets out that the design of a near-surface radioactive waste disposal must be done so as to guarantee the required safety after the 5-year transitional period from the covering of the last disposal unit and without any further active maintenance of the disposal has expired.

H.4.4 Technologies are supported by experience, testing or analysis

Rulebook COLPNA, Article 19, sets out that the systems in the nuclear facility shall be designed so as to ensure, among others:

- application of ergonomic principles;
- required system and component quality;
- operational reliability of systems for executing safety functions and back-up systems such as physical separation, independence, reserves, versatility, single failure principle;
- possibility of their maintenance, trial running, inspection and repair.

H.4.5 Facilities under design and construction

During the process of planning of construction of the new waste storage facilities in 2007-2008 it has been foreseen construction of new and modern waste processing facility. However, lack of financial resources led to the decision to refurbish existing building on the site, close to the new waste storage hangar H3.

Refurbishment of the facility is done under IAEA TC project SRB3004 in 2016. Waste Processing Facility still does not have neither civil license for use nor nuclear license.

H.5 Assessment of safety of facilities

Article 15. Assessment of safety of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;
(ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;
(iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

Under the current regulatory regime, SRPNA would assess any application for the licence for the radioactive waste management facility. Obligatory part of the licencing documentation is safety assessment report and opinion about environmental impact assessment obtained from the relevant Ministry. SRPNA would not licence the facility until the conditions for safety and security are fulfilled and until evidence is provided that facility does not present a hazard for the people and the environment. All applications would have to take due account of the standards for such facilities as promulgated by the IAEA.

H.6 Operation of facilities

Article 16. Operation of facilities

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;
(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15, are defined and revised as necessary;
(iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;

(iv)	engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;
(v)	procedures for characterisation and segregation of radioactive waste are applied;
(vi)	incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;
(vii)	programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;
(viii)	decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;
(ix)	plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

Article 49 of the Law 2009 prescribes that the license for the radioactive waste management may be issued after it has been established that all required nuclear safety measures have been met, based on the nuclear safety report and other required documentation.

Rulebook PNA, Article 6 prescribes that the license holder shall ensure that the license to operate the nuclear facility is based on appropriate safety analyses and operating programmes which prove that the facility's construction is compliant with the design and safety requirements. The same article also prescribes that the licence holder shall ensure that the following criteria are met:

1) Limitations and conditions derived from safety analyses, checks and working experience must be defined and revised for the need to identify safety limits during operation;
2) The operation, maintenance, inspection and control of the nuclear facility must be performed in accordance with approved procedures;
3) Response procedures must be established for events for which it is assumed that they could occur during regular operation as well as in emergencies;
4) All and any emergency that is important for the safety must be reported to the SRPNA within the legally stipulated period of time;
5) The radioactive waste generated during the performance of nuclear activities is reduced to the minimum, both in respect of the activities, as well as in respect of the volume, and procedures necessary for the treatment and storage of spent fuel and radioactive waste obtained from nuclear activities and located at the location of the nuclear facility must take into account the requirements for conditioning and disposal.

The license holder shall provide the necessary engineering and technical support in all areas important for nuclear safety during the performance of nuclear activities.

The license holder shall prepare a Programme for gathering and analysis of operational experience and ensure that the results are available and that the derived conclusions can be used in the exchange of experiences with other license holders, the SRPNA and international bodies and organizations.

Rulebook COLPNA, Article 25 prescribes that along with the license application for commissioning and operation of a nuclear facility, the nuclear facility operator shall submit:

1) the final nuclear safety report with amendments and supplements arisen during the trial run, with expert evaluations and opinions on the amendments and supplements;
2) as built drawings (documentation on executed works, with all amendments and supplements);
3) results of the tests of trial run;
4) the evidence of determined quality of structures, systems and components relevant for safety;
5) the quality assurance plan for the nuclear facility installation;

6) operational conditions and restrictions;
7) the list of working procedures, instructions and rules;
8) the list of programmes and instructions for maintenance and testing of systems and components relevant for safety;
9) the organigram of the plant and the information on jobs, tasks and responsibilities of people handling the systems relevant for the nuclear facility safety and security;
10) the systematic environmental radioactivity monitoring plan in the surroundings of the nuclear facility;
11) the information on the organization of the department and the means for ionising radiation protection;
12) the action plan in case of an accident;
13) the evidence that the conditions for safe storage of radioactive waste have been provided;
14) the evidence that the conditions for safe storage of irradiated nuclear fuel have been provided;
15) the evidence of physical and technical protection of nuclear facilities and nuclear materials and other nuclear security measures.

Rulebook RWM, Article 31 prescribes that if the operator of a near-surface disposal for radioactive waste materials intends to close down the disposal permanently, they previously have to produce a disposal closedown programme.

H.7 Institutional measures after closure

Article 17. Institutional measures after closure

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

(i) records of the location, design and inventory of that facility required by the regulatory body are preserved;
(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and
(iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

Rulebook RWM, Article 31 prescribes that the operator of a near-surface disposal facility undertakes to deliver to the SRPNA the project of performed works, the records about disposed radioactive waste and geodetic survey of the location. The operator of a near-surface disposal facility undertakes to ensure its active maintenance for the period of five years following closure of the disposal units.

Section I. Transboundary Movement

Article 27: Transboundary movement

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

   In so doing:

   (i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorised and takes place only with the prior notification and consent of the State of destination,
   (ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilised,
   (iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention,
   (iv) a Contracting Party which is a State of origin shall authorise a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph
   (v) are met prior to transboundary movement,
   (vi) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.
2. A Contracting Party shall not license the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.
3. Nothing in this Convention prejudices or affects:
   (i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international Act,
   (ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin,
   (iii) the right of a Contracting Party to export its spent fuel for reprocessing,
   (iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin

Based on Article 2 of the Law 2009, it is forbidden to import radioactive waste and spent nuclear fuel of foreign origin in the territory of the Republic of Serbia.

There is no statement in national legislation regarding shipment of spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

Since the Law 2009 entered into force there are no activities regarding transit of radioactive waste and spent nuclear fuel of foreign origin in the Republic of Serbia.

I.1 Experience concerning transboundary movement

Following the lead of an American nuclear fuel return programme, the Russian Federation, the United States and the IAEA launched the so-called Russian Research Reactors Fuel Return Programme in 1999 [8]. One year later, the Director General of the IAEA sent a letter to countries in possession of the Russian origin research reactor fuel to examine interest in returning highly enriched uranium fuel to the Russian Federation. Former Federal Republic of Yugoslavia expressed strong willingness in participating in this programme. At the beginning of 2002, the Yugoslav government issued a directive to repatriate all fresh HEU fuel elements and also all spent LEU and HEU fuel elements used during entire exploitation of the research reactor RA at the Vinča Institute.

The Agreement between the governments of the United States and the Russian Federation, which has been signed in May 2004 in Bratislava, provided legal authority for the realization of the so-called Russian Research Reactors Fuel Return Programme Programme. Four months later, the Ministry of Science and Technology of the Republic of Serbia engaged the Vinča Institute to prepare input data relevant for the spent fuel shipment to the Russian Federation. In the meantime, close cooperation with the IAEA had been established.

Upon the invitation of the IAEA, in May 2005, an international consultancy meeting was held at the Vinča Institute with participation of several invited international enterprises. The main goal of the meeting was to draft the outlines of an international bid for the preparation and transportation technologies of the spent nuclear fuel from the research reactor RA. In September 2006, following an international tender, a tripartite contract for repatriating spent fuel from the research reactor RA was signed. The parties involved included consortium of the Russian companies ("Sosny", "Tenex" and "Mayak"), the Vinča Institute and the IAEA. Work obligations for the Russian companies and for the Vinča Institute were fully determined and distributed among participants. Spent fuel repackaging and loading technology, comprising design and manufacture of special equipment had to be developed and worked out by the Sosny Company, while required facility preparations including repackaging and loading activities had to be carried out by the Vinča Institute. Transportation of all the spent nuclear fuel from the reactor facility, as stated in the contract, had to be completed until the end of 2010 and in one shipment only.

To import spent nuclear fuel into the Russian Federation, a series of extensive preparatory activities was required. Among those, two basic documents had to be elaborated and signed. The first one is the so-called "Government-to-Government Agreement" determining general conditions of the spent fuel import. Such an agreement between the governments of the Russian Federation and of the Republic of Serbia was signed in June 2009. According to this agreement, waste generated by the reprocessing of the spent fuel from the research reactor RA will be permanently stored in the Russian Federation. The second one, the so-called "Foreign Trade Contract", determines all mutual obligations referring to spent fuel transport including the scope of services to be provided by the Russian Federation. In September 2009, such a contract was signed between the PC NFS and the "Federal Centre of Nuclear and Radiation Safety" from the Russian Federation.

Taking into account technological and economic aspects, combined with a request to transport all TVR-S spent fuel elements at once, ŠKODA and TUK-19 casks had been chosen. Both types of casks were certified, acceptable for the Mayak Reprocessing Plant and available by the end of 2010. In order to realize the one-time shipment of all spent fuel elements from the research reactor RA, 32 casks in total were needed.

Considerable effort was required to provide necessary permits and licenses for spent fuel shipment to the Russian Federation. To import spent nuclear fuel into the Russian Federation, a series of documents had to be worked out and then approved by competent Russian authorities. The initial document was certificate for the package design for both TUK-19 and ŠKODA casks. This certificate, issued by Rosatom, enabled elaboration of the so-called Unified Project Documents. This project is basically an

overall assessment of the radiation, economic, social and environmental impact to the country, especially for the Chelyabinsk region (Mayak Reprocessing Plant is located there). When positive assessment issued by the State Ecological Expertise Committee has been submitted to Rosatom, import of spent nuclear fuel was granted and the "Foreign Trade Contract" was signed.

Authorities in the Republic of Serbia validated certificates for the spent fuel package design and then issued approvals and permits for radiation protection procedures, emergency preparedness plans, physical protection procedures and reactor facility operation programmes and procedures. After the Take-back Guarantee and Civil Liability Insurance documents have been provided, Serbian export license for spent nuclear fuel was issued by the SRPNA.

Figure 42. Loading of the ŠKODA cask into ISO container

To provide for transport license in transit countries (Hungary and Slovenia), Regulatory bodies in these countries had to validate spent fuel package design, firstly. After all aspects of spent fuel transit have been discussed and coordinated with Serbian institutions, authorities in these countries issued the so-called Trans-boundary Shipment Authorization and then provided transit approvals.

Finding the proper route for transporting spent nuclear fuel is not at all as simple as it may look like at first. A lot of aspects including political, economic and safety had to be taken into account. However, the final decision depends solely on the goodwill of the transit countries.

It was assumed that transportation of the spent fuel from the research reactor RA would be realized through Hungary and Ukraine. However, negotiations with Ukraine had failed. So, instead of using the shortest route from Belgrade to Ozersk in the Chelyabinsk region, transport was perfomed all around the European continent as shown in Figure 43.

Loading of ISO-containers onto trucks was carried out on November 18th and the convoy consisting of 15 trucks loaded with 32 transport casks and auxiliary equipment left the PC NFS the next day. Loading of the ŠKODA cask into ISO container is shown on the Figure 42. Transportation route was determined almost one year ago, but the timetable was fixed only a few days before transportation. Near the Hungarian border, ISO-containers were reloaded onto railway flatbed cars and transported through Hungary and Slovenia to the Koper harbor. The train arrived to Koper on November 21st. Immediately upon arrival, ISO-containers were reloaded again - from the railway cars onto the ship. Loading of the ISO container to the ship in Koper harbor is shown on Figure 44. A few hours later, the ship left Koper towards Murmansk. It took more than three weeks until the ship reached Murmansk, where ISO-containers were reloaded onto railway cars again and on December 22nd spent nuclear fuel from the

reactor RA arrived to Mayak. During loading of ISO-containers at the reactor RA and along the entire route to the Koper harbor, significant police forces were engaged to provide physical protection of the cargo. At the same time, continuous radiation control had been provided, too.

Figure 43. Spent fuel transportation route

Good planning and organization from the very beginning and extremely good cooperation with many international organizations and institutions, followed up with substantial financial help given by several countries, enabled successful completion of this task.

After repatriations of fresh and spent nuclear fuel, carried out in 2002 and 2010 respectively, the Republic of Serbia lined up alongside other countries in having no highly enriched uranium anymore.

Figure 44. Loading ISO containers to the ship in Koper harbor

Section J. Disused Sealed Sources

Article 28. Disused sealed sources

1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.
2. A Contracting Party shall allow for reentry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

Disused sealed sources are not recognized in national legislation. There is no national strategy for the management of disused sealed radioactive sources.

End of life posibilities for sealed sources in the Republic of Serbia are:

- return to supplier;
- transfer to another legal entity which than has to obtain necessary licence for radiation practice;
- declaraton of source as radioactive waste and transfer to radioactive waste storage.

At the time of writing this report, there is no capacities in the Republic of Serbia for management of disused sealed sources except storage.

Imports in the territory of the Republic of Serbia of radioactive waste and spent nuclear fuel of foreign origin are forbidden by the Law 2009. This provision is applicable to any type of radioactive waste thus also for disused sealed radioactive sources declared as radioactive waste.

Legislative framework and infrastructure for management of disused sealed sources need to be improved.

Section K. General Efforts to Improve Safety

K.1 Summary of safety issues and planned future actions

Republic of Serbia need to substantially improve legislative framework and current infrastructure in the field of spent nuclear fuel and radioactive waste management.

K.1.1 Improvement of the legislative framework

It is recognized that following actions will facilitate improvement of the legislative framework in Republic of Serbia:

- Adoption of the new Law in the field of radiation and nuclear safety and security including spent nuclear fuel and radioactive waste management in accordance with EU *aquis*. Special attention has to be raised relating to dissued sealed sources management, decommissioning, environmetnal remediation and disposal of radioactive waste. Adoption of the new Law will be followed by adoption of set of new bylaws.
- Adoption of National Spent Nuclear Fuel and Radiaoctive Waste Management Policy and Strategy. A national policy should reflect priorities, circumstances, structures, and human and financial resources as well as relevant international instruments and other national policies. The purpose of the national strategy is to set out at the strategic level how the national policy is to be implemented and to specify technical means and measures for the management of spent nuclear fuel and radioactive waste in Republic of Serbia.
- Adoption of strategic level document for the responsible and safe management of nuclear facilities. This document will, among other, provide end-points for decommissioning of all nuclear facilities such as research reactors RA and RB.

K.1.2 Improvement of the infrastructure

It is recognized that past practices resulted in generation of radioactive waste which was not managed in manner that would provide long term safety. Special attention has to be paid to the facilities on Vinča site and former uranium mine in Gabrovnica near Kalna. Breaking point in the improvement of infrastructure will be establishment of waste processing facility.

K.1.2.1 Establishment of Waste Processing Facility

Lack of developed waste processing facility that will be able to manage all waste and spent sealed radioactive sources stored on Vinča site is crucial reason why waste is still not treated. Currently, there are ongoing activities on establishment of radioactive waste processing facility. Decision was made to refurbish existing building on the Vinča site, close to the new waste storage Hangar H3. This facility will enable segregation, compaction and solidification of radioactive waste as well as conditioning of spent sealed radioactive sources of Cat. III, IV and V. Refurbishment of the facility is done under IAEA TC project SRB3004 in 2016. WPF still does not have neither civil license for use nor nuclear license.

K.1.2.2 Hangars H1 and H2

The largest part of radioactive waste in the Republic of Serbia is stored in two old storages – hangars H1 and H2. As mentioned in Section D the current situation of the hangar H1 is unacceptable from the point of radiation safety. Beside this, capacity of hangar H2 is completely filed. Records on waste in both facilities are incomplete.

Estimated volume of radioactive waste stored in old radioactive waste storages is given in Section D and Annex L.1. Part of stored radioactive waste is packed in various types of containers of which some are not any more suitable to provide adequate shielding and to prevent spread of contamination. Also,

part of radioactive waste was never properly packed in containers. Similar situation is with sealed sources.

Activities regarding removal, treatment and adequate storage of radiaoctive waste stored in old storage hangars were planned under IPA project programmed in 2008 and funded by the European Commission. Under this project all radioactive waste stored in these facilities was planned to be taken out, treated and stored in new storage facilities. Financing of this project was stopped in 2016 and project is only partally done. PC NFS is licence holder responsible for these activities.

K.1.2.3 Liquid radioactive waste

Liquid radioactive waste in Serbia is stored in underground liquid waste tanks VR1 – VR4 and spent fuel storage of the research reactor RA. Currently there are no posibilities for treatment of liquid waste in Serbia. All newly generated liquid waste is temporarley kept until treatment options are available.

From the radiological point of view the treatment of liquid radioactive waste stored in these tanks, decontamination and/or dismantling of the old piping system and tanks proves to be quite important since some of the tanks may leak in the future. If so radioactive contamination of the underground aquifer and of the water table may occur.

Activities regarding treatment of liquid radiaoctive waste were planned under IPA projects programmed in 2009 and 2010 and funded by the European Commission. Under this project all liquid radioactive waste stored in four underground waste tanks and in spent fuel storage pool was planned to be treated and stored in new storage facilities. Financing of this project was stopped in 2016 without any activities done.

In 2017 European Commission agreed to fund project which covers sampling and analyzing radioactive liquid waste stored on Vinča site in spent nuclear fuel pool, adjacent piping and tanks, soil testing in adjacent areas, and proposing of problem solving technology.

K.1.2.4 Radium Bunker

Retrieval of radium sources stored in so-called Radium Bunker presents risk form radiological point of view. Detailed description of Radium Bunker is given in Section B.

In 2017 European Commission agreed to fund project wich main objective is to retrieve, to process and to store the radium sources.

K.1.2.5 Former uranium mine in Gabrovnica

The facilities at Gabrovnica near Kalna are in very bad condition, most of buildings are ruined and useless. There is no any decision regarding future activities at this site. By decision of the Government of Serbia on the establishment of the PC NFS in 2009 responsibility for this site was transferred from the Institute for Technology of Nuclear and Other Mineral Raw Materials to the PC NFS.

Removal of contaminated equipment and material and remediation of the site is necessary from the safety point of view.

K.2 Previous review meetings

Republic of Serbia did not participate in previous review meetings.

K.3 International peer review missions

Republic of Serbia did not hosted International peer review missions.

K.4 Openness and transparency

This national report is available on web site of the SRPNA.

Section L. Annexes

L.1 Inventory of radioactive waste

Table 3. Inventory of solid and liquid radioactive waste in Hangar H3 and Hangar H0

LLW	Radionuclides	Volumes [m^3]
Solid in H3	^{137}Cs, ^{226}Ra, ^{238}U, ^{232}Th, ^{3}H, ^{241}Am, ^{60}Co and ^{90}Sr.	31.8
Liquid in H0	^{137}Cs and ^{3}H	0.37

Table 4. Inventory of spent sealed sources in Secure Storage and Hangar H3

Category	Location	Radionuclides	Number
I	Secure Storage	^{60}Co	1
III and IV	Secure Storage	^{137}Cs, ^{226}Ra, ^{85}Kr, ^{232}Th, ^{241}Am, ^{60}Co, ^{152,154}Eu, ^{90}Sr and ^{241}Am/Be neutron sources	454
V	Secure Storage	^{3}H, ^{68}Ge, ^{63}Ni, ^{137}Cs and ^{90}Sr	16
V	Hangar H3	^{226}Ra	10016
V	Hangar H3	^{241}Am	9269

Table 5. Inventory of radioactive waste in Hangar H1

Radioactive waste type	Radionuclides	Quantity
Radioactive waste from different users	Unknown	330 m^3
Technological, irradiation and ventilation channels	Fission and activation products	40 m^3
Plastic bags and plastic containers with “yellow cake”	^{235}U, ^{238}U	10 m^3
Radioactive waste from the laboratory for reactor material sciences	^{235}U, ^{238}U	4 m^3
Transuranic liquid waste		4 m^3
Empty plastic containers	Unknown	5 m^3
Waste from HOT laboratory	Unknown	20 m^3
Glove boxes from laboratory 060	Unknown	6 m^3
^{60}Co and ^{137}Cs spent sealed radioactive sources	^{60}Co, ^{137}Cs	Aprox. 300 pcs
Cat. IV spent sealed radioactive sources from lightning rods	$^{152,154}Eu$, ^{60}Co	Aprox. 200 pcs
Other spent sealed radioactive sources	^{137}Cs, ^{60}Co, ^{226}Ra, etc.	Aprox. 200 pcs

Table 6. Inventory of radioactive waste in Hangar H2

Radioactive waste type	Radionuclides	Quantity
Radioactive waste from former open repository	Unknown	200 m^3
Air filters gathered after Chernobyl accident		60 m^3
Radioactive waste from various users	Unknown	90 m^3
Solidified sludge from the reactor pool	^{137}Cs	6 m^3
Spent sealed sources from radioactive lightning rods	$^{152,154}Eu$;	3 special collective containers with total of 625 sources
Depleted uranium bullets	^{235}U, ^{238}U	3 metal containers with 300 bullets
Depleted uranium bullet shells made of Aluminum	^{235}U, ^{238}U	2 metal containers
Soild contaminated with depleted uranium	^{235}U, ^{238}U	3 m^3
Contaminated metal pipes	^{226}Ra	0.2 m^3
Contaminated scrap metal	^{226}Ra	1.6 m^3
Radioacitve waste from spent fuel repackaging operation	^{60}Co, ^{137}Cs	25 stainless steel containers with volume of 77 liter
Compressible operational waste from spent fuel repackaging operation	^{60}Co, ^{137}Cs	80 m^3
Contamianted metal waste	^{137}Cs	22 m^3
Contaminated soil	^{137}Cs	24 m^3
Cat. V sources from smoke detectors	^{241}Am, ^{85}Kr, ^{226}Ra	100000 pcs
Industrial spent sealed radioactive sources		Approx. 800 pcs

Table 7. Inventory of radioactive waste in surroundings of hangars H1 and H2

Radioactive waste type	Radionuclides	Quantity
Contaminated metal waste	^{137}Cs; ^{226}Ra; ^{235}U, ^{238}U	5 Full ISO Containers 7 Half Length Half Height ISO Containers
Contaminated metal waste from spent fuel pool	^{60}Co, ^{137}Cs	
Contaminated metal waste from spent fuel repackaging operation	$^{152,154}Eu$	

Table 8. Inventory of liquid radioactive waste stored in underground tanks

Tank no.	Radiaoctive Waste Class	Quantity [m^3]
VR-1	ILW	123.6
VR-2	LLW	383.6
VR-3	LLW	223.3
VR-4	LLW	139.3

Table 9. Inventory of radioactive waste stored in Radium Bunker

Radioactive waste type	Radionuclides	Quantity
Radium sources	^{226}Ra	Approx. 7 g

Table 10. Inventory of legacy waste stored in Hangar H0

Radioactive waste type	Radionuclides	Quantity
Sealed sources	^{60}Co, $^{152,154}Eu$, ^{137}Cs	Unknown
Contaminated ventilation channels	Unknown	Unknown

L.2 References to national laws, regulations, requirements, guides, etc.

L.2.1 National legal acts

L.2.1.1 National laws

- Law on Radiation Protection and on Nuclear Safety (Official Gazette RS 36/09 and 93/12);
- Law on banning the construction of nuclear power plants (Official Gazette FRY 12/95 and Official Gazette RS 85/05)
- Law on Public Agencies (Official Gazette RS 18/05 and 81/05);
- Information Secrecy Law (Official Gazette RS 104/09);
- Law on Budget System (Official Gazette RS 54/09, 73/10, 101/10, 101/11, 93/12, 62/13, 63/13-corr., 108/13, 142/14, 68/15- other law, 103/15, 99/16 and 113/17);
- Law on Emergency Situations (Official Gazette RS 111/09, 92/11 and 93/12);
- Law on Environmental Impact Assessment (Official Gazette RS 135/04 and 36/09);
- Law on Free Access to Information of Public Importance (Official Gazette RS 120/04, 54/07, 104/09 and 36/10);
- Law on General Administrative Procedure (Official Gazette RS 18/16);
- Law on Government (Official Gazette RS 55/05, 71/05 (Corrigendum), 101/07, 65/08, 16/11, 68/12 (CC), 72/12, 74/12 CC (Corrigendum), 7/14 (CC) and 44/14);
- Law on Occupational Health and Safety (Official Gazette RS 101/05, 91/15 i 113/17-other law);
- Law on Public Procurement (Official Gazette RS 124/12, 14/15 and 68/15);
- Law on State Administrative Fees (Official Gazette RS 43/03, 51/03 - corr., 61/05, 101/05 – other law, 5/09, 54/09, 50/11, 70/11 – adj. din. amounts, 55/12 - adj. din. amounts, 93/12, 47/13 - adj. din. amounts, 65/13 – other law, 57/14 - adj. din. amounts, 45/15 - adj. din. amounts, 83/15, 112/15, 50/16 - adj. din. amounts, 61/17 - adj. din. amounts and 113/17);
- Law on Transport of Dangerous Goods (Official Gazette RS 104/16);

L.2.1.2 Governmental regulations and decisions

- Regulation on determining the programme of nuclear safety and security (Official Gazette RS 39/14)
- Regulation on the security measures of nuclear facilities and nuclear materials (Official Gazette RS 39/14)
- Decision on Determining Goods Subject to Issuance of Specific Documents on Importation, Exportation and Transit (Official Gazette RS 32/15, 109/15 and 92/17);
- Decision on determining the National Control List of Dual-Use Goods (Official Gazette RS 29/16);
- Decision on establishment of the Serbian Radiation Protection and Nuclear Safety Agency (Official Gazette RS 76/09 and 113/13)
- Decision on Establishment of public company for nuclear facility management (Official Gazette RS 50/09)

L.2.1.3 Regulations

- Rulebook on performance of nuclear activities (Official Gazette RS 37/11)
- Rulebook on conditions for obtaining licence to perform nuclear activity (Official Gazette RS 37/11)
- Rulebook on radioactive waste management (Official Gazette RS 60/11)
- Rulebook on procedure for keeping records of nuclear materials (Official Gazette RS 27/11)
- Rulebook on limits of exposure to ionizing radiation and measurements for assessment of the exposure levels (Official Gazette RS 86/11)

- Rulebook on radioactivity monitoring (Official Gazette RS 97/11)
- Rulebook for establishing Programme of systematic environmental radioactivity monitoring (Official Gazette RS 100/10)
- Rulebook for establishing programme of early warning of emergency (Official Gazette RS 70/11)
- Rulebook on records on performed activities in the field of ionizing radiation protection (Official Gazette RS 17/11)
- Rulebook on registration and notification of sources of ionising radiation (Official Gazette RS 25/11)
- Rulebook for establishing programme of additional training and specialized education of occupationally exposed persons and persons responsible for implementation of radiation protection measures (Official Gazette RS 31/11)
- Rulebook on limits of radioactive contamination of people, working and living environment and ways of performing decontamination (Official Gazette RS No. 38/11)
- Rulebook on radioactivity control of goods during the import, export and transit (Official Gazette RS 44/11)
- Rulebook on conditions for obtaining decision to perform activities in the field of radiation protection (Official Gazette RS 61/11)
- Rulebook on conditions for obtaining licence to perform radiation practice (Official Gazette RS 61/11)
- Rulebook on limits of radionuclides content in drinking water, foodstuffs, feeding stuffs, medicines, general use products, construction materials and other goods that are put on market (Official Gazette RS 86/11 and 97/13)
- Rulebook on the records of ionizing radiation sources, professionally exposed persons, patients exposure to ionizing radiation and radioactive waste (Official Gazette RS 97/11)
- Rulebook on application of the ionising radiation sources in medicine (Official Gazette RS 1/12)

L.2.2 International instruments

L.2.2.1 Multilateral treaties

- Convention on Early Notification of a Nuclear Accident
- Convention on Assistance in the Case of a Nuclear Accident or a Radiological Emergency
- Convention on Physical Protection of Nuclear Material
- Amendment to the Convention on the Physical Protection of Nuclear Material
- Vienna Convention on Civil Liability for Nuclear Damages
- The Treaty on Non-Proliferation of Nuclear Weapons
- Agreement between SFRY and the IAEA for the Application of Safeguards in connection with the Treaty on Non- Proliferation on Nuclear Weapons
- Nuclear Safety Convention
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
- International Convention for the Suppression of Acts of Nuclear Terrorism
- The IAEA Incident Reporting System (IAEA-IRS)
- Comprehensive Nuclear-Test-Ban Treaty
- Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction in the Sea-Bed and the Ocean Floor
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water
- Convention on the Prevention of Marina Pollution by Dumping of Wastes and Other Matter

– The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal

L.2.2.2 Bilateral trities

– Agreement between the Government of Hungary and the Government of the Republic of Serbia for the Early Exchange of Information in the Event of Radiological Emergency

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[3] Radioactive Waste Management Strategy, Vinča Instute of Nuclear Sciences, 2006

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[6] Final Safety Analyses Report for radioactive waste storage facility H3 including H0 (in Serbian), PC NFS, December 2017

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